HE ENGINEERING CONSTRUCTION WEEKLY

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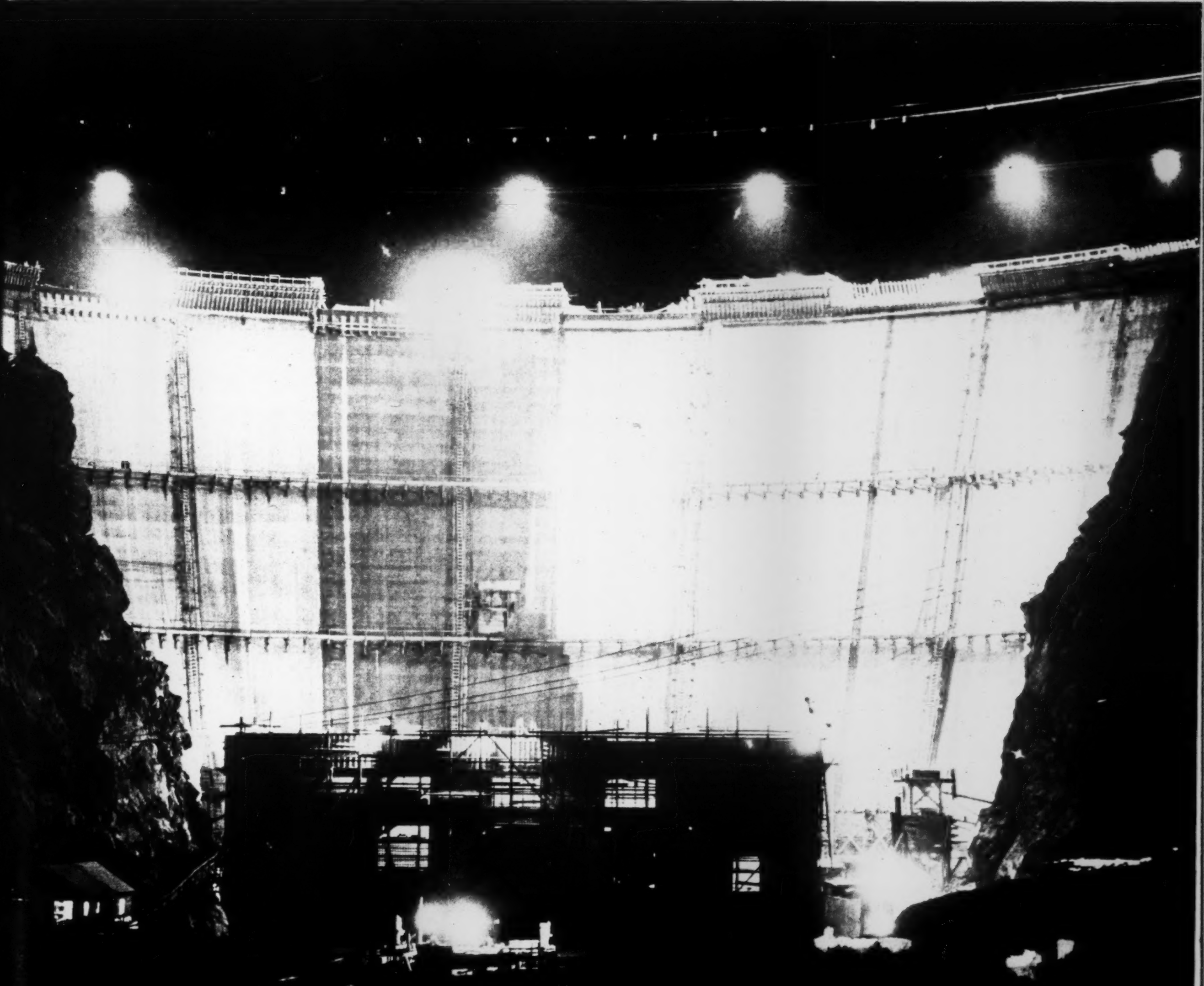
# Engineering NEWS-RECORD

December 29, 1938

*Topping out Seminoe Dam, Wyo.*



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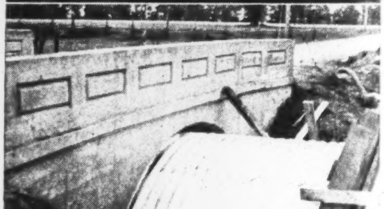
# NARROW BRIDGES BRING Sudden Death

INTERNATIONAL NEWS PHOTO



## But You Can Help Prevent Accidents BY WIDENING "THE WORST 10%" NOW

No road is any safer than its bridges. With modern speeds, night driving and slippery pavements, every small narrow bridge is a potential "death trap." Warning signs help, but they don't eliminate the physical hazard.

For safety's sake, start now to extend or replace "*the worst 10%*" of all narrow bridges in your district. Such a program is sure to win public praise because it will save lives, reduce bridge maintenance costs and add greatly to the appearance of your roads.

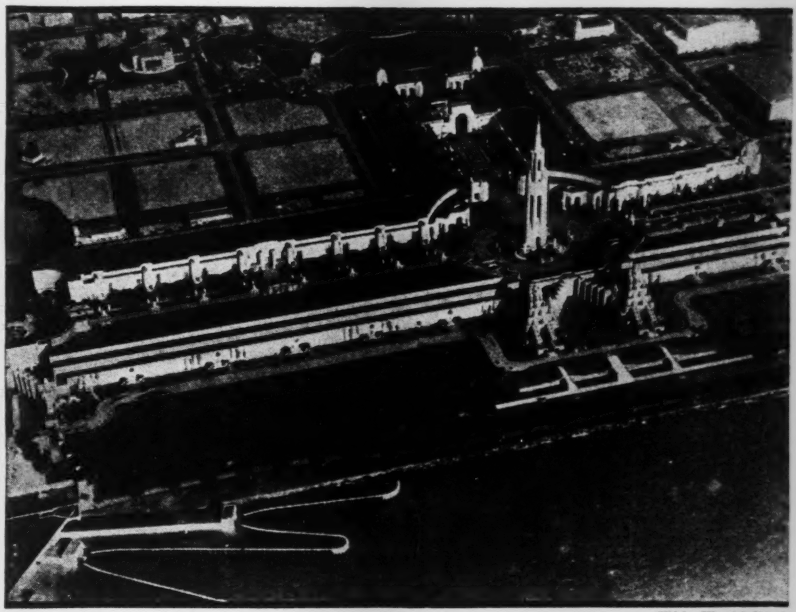
To make these improvements lasting yet low in cost, you'll want to consider Armco Multi Plate pipe and arches. Regardless of weather conditions, they are quickly erected by unskilled labor; and they serve a lifetime without upkeep or repairs. For more complete information about Multi Plate, see your Armco representative or write to the Armco Culvert Mfrs. Association, Middletown, O.

**ARMCO MULTI PLATE**

A PRODUCT ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

· ENGINEERING NEWS-RECORD ·
DECEMBER 29, 1938

# THE WEEK'S EVENTS



Wide World Photo

**WESTERN FAIR GROUNDS NEAR COMPLETION**

SLIPS for the ferry boats which will carry visitors from San Francisco to artificial Treasure Island, site of the 1939 Golden Gate International Exposition, are seen above in front of the Tower to the Sun, theme structure of the exposition, surrounded by exhibit palaces.

## Centralized Control Of Transport Urged

**President's committee proposes changes in system of regulating transportation agencies**

Major changes in the nation's system of regulating and fostering transportation are proposed in a report submitted to President Roosevelt Dec. 23 by a committee he appointed last September to look into the difficulties of the railroads and to recommend how those difficulties can be reduced or eliminated. The committee consisted of M. W. Clement, president, P.R.R.; Carl R. Gray, Union Pacific; George M. Harrison, Ry. Labor Executives Assn.; B. M. Jewell, A.F.L.; Ernest E. Norris, Southern Ry.; D. B. Robertson Brotherhood of Locomotive Enginemen & Firemen.

Absence of a clearly defined national transportation policy was stated by the committee to be the principal cause of the present national transportation problem—intensified by wasteful competition, unequal regulation, and inequitable subsidies. The committee urges the adoption of a definite national transportation policy providing for fair, impartial regulation of all modes of transportation, so administered as to preserve the inherent advantages of each.

### New agency proposed

The committee recommends that a "transportation board" be established, this to be a new and independent agency charged with the duty of investigating and reporting to Congress concerning the relative economy and fitness of the several modes of transportation and the extent to which any of them is now being subsidized, with recommendations for further legislation. Thereafter the board would be responsible for the unified development of the nation's transportation system including issuing of certificates of convenience and necessity covering new construction or abandonment of existing facilities, issuance of new securities, consolidation, mergers, leases, etc., exercising all control over transportation except with respect to rates, services and accounting, which would be under the control of the Interstate Commerce Commission.

The committee recommended repeal of the present rate-making rule in the Interstate Commerce act and substitution of a new rule covering all modes of transportation, repeal of the long-and-short-haul clause of the act, extension of the powers of the ICC with respect to intrastate rates, the establishment of a fair and reasonable system of tolls for commercial use of certain inland waterways and elimination of the Inland Waterways Corporation, repeal of the reduced rate provisions of the so-called land-grant statutes, elimination of taxes believed to be unjust to the railroads and elimination of the present requirement that railroads bear a large part of the cost of elimination of grade crossings and the reconstruction of bridges and rail lines in connection with navigation and flood control projects.

The committee recommended elimination of the present plan whereby the Interstate Commerce Commission is required to develop a consolidation plan for the entire railroad system of the country. Initiative in the development of consolidations of railroad systems would be left to the railroads, federal

(*Continued on page 807*)

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## Bids Are Advertised For Shasta Generators

The U. S. Bureau of Reclamation has asked for bids, to be opened Jan. 19, on manufacture and installation of four 75,000-kw. generators which will be installed in the hydroelectric plant at Shasta Dam in the Sacramento River, Calif.

Specifications provide that the four generators be installed within a period ranging from 1,050 to 1,320 days after the government gives notice to proceed with the work. Each generator will be direct connected by a vertical shaft to a 103,000-hp. turbine. The turbines will be manufactured under separate contract.

## *States Draft Plan On Boulder*

**Colorado Basin states draw up agreement on allocation of Boulder Dam power revenues**

Representatives of the seven Colorado River Basin States reached unanimous agreement on proposed federal legislation governing the financial operations of Boulder Dam at a conference held last week at Phoenix, Ariz. State representatives initialed a rough pact which will be officially ratified at a later meeting probably to be held in January and then submitted to the state legislatures for final ratification. The program proposed by the states would then have to be adopted by the next Congress as an amendment to the Boulder Dam Act.

Major provisions of the agreement provide that the ten purchasers of power from Boulder Dam, located in California, Arizona, and Nevada, will pay $500,000 annually into a separate fund earmarked by the U. S. Treasury for appropriation to reclamation projects in the basin states. The first three payments will be used for a comprehensive survey of the entire Colorado River basin and thereafter money will be allocated to the four upper basin states for a period of twelve years. From then on the sum will be pro rated equally among the seven states.

Beginning either in 1940 or retroactively in 1937 (there is some confusion as to the terms of this clause), the states of Arizona and Nevada will receive annual payments of $300,000 until 1987.

In return for these concessions, the power purchasers will receive the following:

Amortization of the $25,000,000 charged to flood control at Boulder Dam will be deferred for 50 years. Interest rates on money due the federal government will be reduced from 4 to 3½ per cent, and power rates at the dam, which are now 1.63 mills per kilowatt-hour, will be reduced.

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## *Engineers Cleared In Damage Suit*

Officers and executives of the American Society of Mechanical Engineers were cleared of charges of flagrant carelessness in the use of the society's funds in a decision of the Appellate Division of the New York State courts reversing the findings of a lower court that the funds had been carelessly spent. The decision is expected to bring to a close a long controversy growing out of the use of funds of the society to assist in the publication of the Engineering Index during the period 1927-1934.

Fourteen members of the society joined in bringing suit. Among those charged with misuse of funds were Charles M. Schwab, who served as president of the society during part of the period in question, C. E. Davies, secretary of the society, Prof. Charles M. Allen of Worcester Polytechnic Institute, and Dean Dexter S. Kimball of Cornell. The lower court found that more than $200,000 had been carelessly spent, but the appellate court, in a unanimous decision, held that publishing such an index was for the advancement of the science of engineering, in which the society is primarily interested.

*ENR Staff Photo*

William F. Carey

His landfills will be looked into

## *Landfills in New York To Be Investigated*

The landfill method of refuse disposal is to be investigated in New York by a special committee of the City Council to determine whether the Department of Sanitation is maintaining a public nuisance in the various localities where these operations are conducted (*ENR* Sept. 1, 1938, pp 256, 270). The committee is further charged with making a complete investigation of the administration of the department, which is under the direction of Commissioner William F. Carey.

Among the matters which will be investigated by the committee are why half of the city's incinerators are closed down, whether $7,000,000 spent for new motor equipment "has been well and honestly expended", and "whether there was practiced fraud, collusion and other illegalities in connection with the letting of a contract for the construction of 30 steel scows" (*ENR* Aug. 4, 1938, p. 127).

## *Year's WPA Program Proposed by New York*

A program of WPA projects to be carried out in New York City under city, state, and federal sponsorship has been proposed to the WPA by Mayor La Guardia of New York. The program involves projects costing $208,801,000 and is intended to provide employment throughout the year for about 175,000 employees. All the projects in the program are assigned an order of priority, and the program is so drawn up that, if the amount available for WPA projects should not be as great as expected, the program can be modified without serious disorder.

Of the program, $144,039,000 is for construction projects, and in addition there are included in the white-collar projects fourteen engineering surveys to cost $3,545,000.

Generally speaking, the program provides for highway, sewer, demolition and landscaping work under the sponsorship of the borough presidents, for demolition of 900 buildings for the New York City Housing Authority, and for a large number of repairs and improvements to public buildings, parks and services of the various departments of the city.

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## *Public Works Course Offered at N.Y.U.*

Intended primarily to give engineers a picture "of the possibilities and problems confronting them in the field of public administration," a course in public works organization and administration is being offered in the coming semester by the Graduate Division for Training in Public Service of New York University, New York City.

Beginning Feb. 2, the course will include a study of the federal government's public works activities, the relation of public works to public health, state and county organization for public works, and a special study of state and interstate agencies operating in New York. Public works activities of municipal government will be intensively studied and the course will also include a study of capital budgets and public works programs.

The course will be under the direction of Harold M. Lewis, formerly executive engineer for the committee on regional plan of New York and its environs and now chief engineer and secretary of the Regional Plan Association, Inc. Lewis is also a consultant for the National Resources Committee and for the town planning board of Montclair, N. J. Tuition charge for the course will be $33.

## CNR to Resume Work On Montreal Station

The Montreal terminal of the Canadian National Ry, which was started and subsequently abandoned about ten years ago, is again to go forward, the CNR has announced. It is planned to spend about $12,600,000 over the course of the next few years, and bids are to be called immediately for about $4,000,000 worth of work to be carried out in 1939. The Canadian federal government is giving some financial assistance to the project.

Work immediately planned includes cleaning out of the existing excavation which was made at the time the project was originally started, general preparation of the site for erection of a terminal station and a mail building, and completion of an overhead railway viaduct from the station site to Victoria Bridge.

# CONTRACTS AND CAPITAL

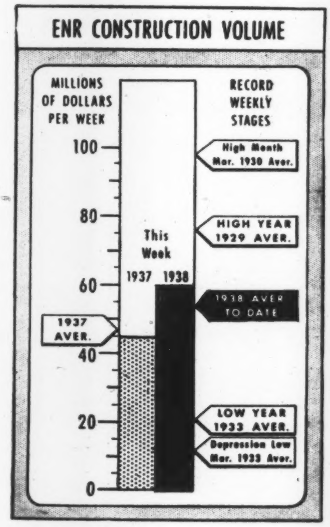
Engineering construction awards for the short week due to the Christmas holiday total $59,510,000, a 32 per cent gain over the volume for the corresponding week last year.

Construction volume for the 52 weeks of 1938, $2,791,931,000, is 14.5 per cent higher than the 1937 total. Public construction, at $1,991,175,000, is 51 per cent above a year ago, while private awards, at $800,756,000, are 28 per cent below last year.

The current week's public construction total is 88 per cent higher than the 1937 week, but private volume is 39 per cent lower.

In the classified construction groups, industrial buildings are at their second highest weekly level of the year, due to a $7,250,000 contract for a steam generating station at Oswego, N. Y. In addition to industrial buildings, waterworks, sewerage, bridges, public buildings, earthwork and drainage and highways report gains over a year ago, while industrial buildings and highways are above a week ago.

New capital for construction purposes for the week, $24,564,000, is 105 per cent higher than a year ago. The week's new financing is made up of $21,003,000 in state and municipal bonds, $2,500,000 in RFC loans for public projects, and $1,061,000 in corporate security issues.



New construction capital for 1938 totals $3,704,201,000, a 68 per cent increase over the 1937 volume.

### CONTRACTS

(Thousands of dollars)

| | Week Ending<br>Dec. 30<br>1937 | <br>Dec. 22<br>1938 | <br>Dec. 29<br>1938 |
|---|---|---|---|
| Federal ..... .. | $3,359 | $10,614 | $3,559 |
| State & Municipal | 21,936 | 61,625 | 44,007 |
| Total public .. | $25,295 | $72,239 | $47,566 |
| Total private.. | 19,694 | 14,358 | 11,944 |
| TOTALS ...... | $44,989 | $86,597 | $59,510 |

Cumulative
1938 .... (52 weeks)....$2,791,931
1937 .... (52 weeks)....$2,437,623

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

### NEW PRODUCTIVE CAPITAL

| | Cumulative<br>1937<br>52 Wk. | <br>1938<br>52 Wk. |
|---|---|---|
| NON-FEDERAL ..... | $1,455,950 | $2,560,506 |
| Corporate securities | 516,983 | 376,845 |
| State & Mun. bonds | 530,902 | 757,460 |
| PWA loans, grants | 178,126 | 723,265 |
| RFC loans ....... | 29,939 | 104,344 |
| U.S.H.A. loans.... | ...... | 320,986 |
| R.E.A. loans...... | ...... | 76,106 |
| Federal Aid-highways | 200,000 | 201,500 |
| FEDERAL ......... | $746,223 | $1,143,695 |
| TOTAL CAPITAL | $2,202,173 | $3,704,201 |

### FHA MORTGAGES

| | Week Ending<br>Dec. 25<br>1937 | <br>Dec. 17<br>1938 | <br>Dec. 24<br>1938 |
|---|---|---|---|
| Selected for appraisal .... | $6,068 | $19,452 | $18,000* |

Cumulative
1938 ...(51 weeks)....$996,673*
1937 ...(51 weeks)....$581,612

* Subject to revision.

### ENR INDEX NUMBERS

| Index Base | | 1913 | 1926 |
|---|---|---|---|
| Construction Cost | Dec. | 234.89 | 112.87 |
| Building Cost | Dec. | 196.07 | 105.99 |
| Volume | Nov. | 199 | 87 |

## Lincoln Tunnel Shows Deficit

### But Port Authority's total operations for year ending November show surplus

After about eleven months of operation, the Lincoln tunnel under the Hudson River, connecting midtown Manhattan with New Jersey, had accumulated a total deficit for the year ending November 1938 of $921,000. The tunnel was opened to traffic Dec. 22, 1937. Total income of the tunnel from tolls and other sources amounted to $951,000, while operating expenses were $627,000 and interest and other charges amounted to $1,246,000.

Although two other facilities of the Port of New York Authority, the Arthur Kill bridges, and the Bayonne Bridge, showed deficits for the year ending in November of $210,000 and $239,000, respectively, the authority as a whole ended that period with a net income of $4,428,000. This arose from a net income showing of $3,499,000 for the Holland Tunnel and $1,980,000 for the George Washington Bridge.

The authority's net income was 17.3 per cent lower than in the preceding twelve months, reflecting, in addition to the Lincoln tunnel deficit, a drop of 4.9 per cent in Holland Tunnel net income and 3.8 per cent in George Washington Bridge income. The authority's Inland Terminal No. 1, on the other hand, showed a gain of 126.9 per cent over the preceding year, bringing net income to $147,000.

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## Contractor Blameless In Levee Failure

Failure of the new lower levee on Prairie du Pont Creek north of Dupo, Ill., recently, has been held not the fault of the contractor by Lt. Col. P. S. Reinecke, U. S. District Engineer. A 5,000-ft. section of the levee, which extends east from the Mississippi River, subsided about 12 ft. shortly after it had been completed by Morrison-Knudsen Co. The work, according to Reinecke, consisted of raising and strengthening an old levee, and the additional weight of the new construction caused the outer portion to fall.

Repair work, which is being carried out by Morrison-Knudsen at government expense, consists of filling an old pit on the south side of the levee and placing new fill on the levee in order to squeeze water out of the subsoil. Cost of the work, according to Colonel Reinecke, will range from $15,000 to $30,000, depending on the weather.

## *New Bids Taken On Pontoon*

**Second letting brings satisfactory bids for Lake Washington pontoon bridge at Seattle**

Bids described as "satisfactory and below the estimated cost" were received last week by the Washington State Toll Bridge Authority for construction of the four units of the Lake Washington pontoon bridge on which it had rejected the first bids received Nov. 29. (*ENR*, Dec. 8, 1938, p. 720).

J. H. Pomeroy of San Francisco, Parker-Schram of Portland, and the Puget Sound Bridge & Dredging Co. of Seattle, combined to submit a low bid of $3,254,000 for construction of the pontoon bridge itself. The General Construction Co. of Seattle and the Columbia Construction Co. of Bonneville, Ore., whose joint bid of $3,795,000 was rejected at the first opening, were second on the present bid with an offer of $3,493,000. Bates & Rogers of Chicago, who did not bid previously, offered $3,603,000.

The Puget Construction Co. of Seattle was low bidder on each of the other three units, bidding $447,000 for the western approach, $465,000 for the eastern approach, and $527,000 for a bridge over the channel separating Mercer Island on the east from the mainland. Bids have not yet been awarded.

After the first bids were rejected, specifications were revised to provide for the use of steel instead of concrete at a number of points on the bridge.

### *City endorses bridge*

The Seattle City Council last week passed a resolution endorsing the pontoon bridge project after a telegram had been received from PWA to the effect that the grant for the bridge project would be rescinded unless the council favored the improvement. It is believed in Seattle that the telegram came from Washington as the result of protests made by a group in the city which is opposing the bridge project.

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## *Water Tank Explosion Wrecks Pump House*

The unexplained explosion of a large water tank at Bricelyn, southern Minnesota village, on Dec. 14 wrecked a 60x50-ft. brick building housing pumping equipment and moved the water tank 5 ft.

In service for the past 37 years, the tank, part of the village water supply, was 96 in. in diameter and 40 ft. long. It carried water at a pressure of 55 lb. and is reported to have registered normal pressure a few moments before the explosion.

**FRANK BARNES HONORED BY BELGIAN KING**

King Leopold III, of Belgium, has awarded Frank W. Barnes the rank of Officer of the Crown in recognition of his services in driving the Schelde River Tunnel at Antwerp in 1930-32. Barnes, now construction manager of Merritt-Chapman & Scott, was formerly associated with Parsons, Klapp, Brinckerhoff & Douglas, consulting engineers for the Belgian government on the 5,800-ft. vehicle tunnel. He directed construction operations on the project.

The citation, which includes a scroll and a medal, has previously been awarded to Ole Singstad, Walter J. Douglas and S. A. Thoresen for their part in the tunnel project.

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## *Harrington Named WPA Administrator*

Col. Francis C. Harrington has been named acting WPA administrator to fill the place vacated by the appointment of Harry L. Hopkins as Secretary of Commerce. Recently assistant to Hopkins, Harrington has been connected with the Army Engineers for 30 years, ever since his graduation from West Point in 1909. He served overseas during the war with the temporary rank of colonel and in 1920 was returned to the grade of major. He served as district engineer of Baltimore for four years, was assistant engineer of maintenance on the Panama Canal until 1927, spent two years at the command and general staff school and the Army War College, and was assigned to duty with the War Department's General Staff.

Harrington served four years with the General Staff and attended the Ecole de Guerre in Paris in 1935. After a few months as assistant division engineer with the North Atlantic Division he was detailed to WPA in January, 1936, as chief engineer.

## *Louisiana Buys and Frees Pontchartrain Bridge*

The Pontchartrain toll bridge across the narrow end of Lake Pontchartrain east of New Orleans passed under public ownership and became a free bridge Dec. 19 when the Louisiana Highway Commission bought the structure at a bankruptcy sale, offering the sole bid of $600,000.

The bridge and ten miles of asphalt paved approaches were built in 1928 by the Pontchartrain Bridge Co. at a cost of about $5,000,000. At that time it offered the only alternative to a longer route around the end of the lake which involved the use of a number of narrow and obsolete bridges across small streams.

Immediately after the bridge was built, however, the state improved the free route and installed new bridges so that the bridge was never a financial success and went into receivership within a year. Subsequent analysis indicated that even had all traffic, including that using the competing free road, been confined to the Pontchartrain bridge, revenues would have been insufficient.

The bridge, a 4.6-mile concrete structure carries a 30-ft. roadway and includes two bascule lift spans, one 110 ft. long and the other 150 ft.

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## *Mobile Vehicle Tunnel Gets PWA Grant*

PWA has made a grant of $1,500,000 to help finance a $4,000,000 vehicle tunnel under the Mobile River at Mobile, Ala. It is expected that RFC will meet the balance of the cost.

The tunnel, from Mobile to Blakeley Island, will have an overall length of 3,300 ft. and a width of 27 ft. In its construction, 250-ft. sections of tubing will be floated out in the river and sunk into position in a dredged trench in the river bottom.

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## *International Road Meet Delegates Named*

The United States delegation to the Third Pan American Highway Conference, which is to be held at Santiago, Chile, Jan. 13, will be headed by Norman Armour, Ambassador to Chile. Other members of the delegation are Edwin W. James, chief of the division of highway transport of the Bureau of Public Roads; John Van Ness Philip; R. H. Baldock, state highway engineer of Oregon; B. M. Duncan, general manager of the Overseas Highway Improvement District at Key West; John Abbink, president and general manager of Business Publishers' International Corp.

## E. S. Jarrett Dies, Foundation Authority

**Asa H. Morrill, chief engineer of Northern New England Railroad, also among week's deaths.**

Edwin S. Jarrett, 76, builder and engineer and former head of Rensselaer Polytechnic Institute, who had been associated with the design and building of many important structures throughout the country, died Dec. 26 in New York. After his graduation from Rensselaer, Jarrett was connected with Sooy Smith & Co. until 1900.

Two years later he organized and became vice-president of the Foundation Co.

From 1914 to 1928 he was president of the Jarrett-Chambers Co., and in December, 1934, he was elected vice president of Rensselaer, with the duties and powers of the president, to act as head of the institution until the selection in 1937 of a successor to the late president Palmer C. Ricketts. As a part of his extensive organizational activities, he had served as chairman of the New York section of the American Society of Civil Engineers.

**Asa H. Morrill**, 68, chief engineer of the Boston & Maine and Maine Central railroads and the Portland Terminal Co., died Dec. 20 in Portland. After graduating from Massachusetts Institute of Technology in 1892, Morrill worked for several years on railroads in New York and New England and engaged for a short time in contracting. In 1907 he became assistant engineer of construction for the Maine Central. taking on the duties of assistant chief engineer of the Boston & Maine in 1933. He later headed the engineering department on each system. He was a member of many engineering societies and chairman of the New England Committee on Marine Piling and Borer Investigations.

**Harold P. Prather**, 44, WPA engineer who had charge of Cleveland's $4,000,000 Lake Shore boulevard development, was killed Dec. 17 in an auto accident. In 1931 and 1932, Prather was one of two American members of an advisory group that aided the Soviet Union in mapping its second five year plan. Earlier he had been a construction and mining engineer in China, Canada and Alaska.

**Israel Bearce**, 82, for many years an engineer with the Chicago & Northwestern Ry, died in Chicago Dec. 19. He had been employed in the construction of Chicago bridges and the elevated railway there. He retired from the C&NW in 1926.

**William R. Seigle**, chairman of the board and research director of the Johns-Manville Corp., died in Rochester, Minn., Dec. 26 at the age of 59.

**Eugene Schou**, chief of the structural engineering division of the Bureau of Construction of the New York State Board of Education, died recently in Brooklyn. He was 69 years old.

**Ivan L. Bozell**, 48, government engineer in charge of Public Works Administration construction in Kansas, died in Topeka recently.

**Frank Sheehan**, president of the Sheehan Contracting Corp., Albany, N. Y., died there Dec. 26.

**James P. Hall**, former partner in the engineering firm of Rovegno-Hall Co., Jersey City, died there Dec. 23 at the age of 86. Before going into private work he had been a Jersey City waterworks engineer.

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## Standards Group Studies Building Materials

The Standards Council of the American Standards Association has instituted a program of study to develop a basis for coordinating the dimensions of building materials and equipment. This, the council points out, will promote standardization of the features of design of buildings as well as of materials entering into construction.

The present study is intended to go beyond previous standardization of accessories and house utilities and develop a consistent set of standards for the building trades. Objectives include the transfer from the field to the shop of many fabrication operations.

The council has authorized appointment of a technical committee representing all the groups that have an interest in the project.

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## Centralized Control Of Transport Urged

(Continued from page 803)

approval being given by the transportation board. Liberalization of RFC loans to the railroads also is proposed.

The committee favors establishment of a single court vested with exclusive jurisdiction over matters connected with railroad reorganization, the court composed of judges selected with special reference to their experience in and qualifications for this highly specialized service. The ICC would be relieved of all responsibility in connection with railroad reorganization.

## WASHINGTON HIGHLIGHTS

*Special reports by Paul Wooton*

Press reports to the effect that the Bureau of Public Roads will report to Congress next month that cross-continental superhighways are not needed are based entirely on newspaper writers' guesses. The bureau has not yet given any official intimation of what it will report. All present indications, however, suggest that the press stories are substantially correct.

Sufficient snow has fallen in the mountains and rain in the low lands to relieve apprehension felt by the Office of Indian Affairs and the Bureau of Reclamation because of the shortage of water at Coolidge Dam and the dams along Salt River. There has been no interference with irrigation yet, but had the dry cycle continued through this winter a serious situation would have arisen next summer.

A dry cycle has been operating ever since completion of Coolidge dam in 1928. There were only a few thousand acre-feet left in the reservoir at the end of last summer.

A big backlog of federal projects has been built up. Applications pending before the Public Works Administration call for grants of nearly $2,000,000,000. Since municipalities in every congressional district have expended time and money in preparing these applications there will be a strong demand for additional PWA money at the forthcoming session of Congress. If Congress shows any disposition to withhold further funds, the combined pressure of applicants and their representatives in Congress will be brought to bear on the Reconstruction Finance Corporation which has authority to make loans for public projects.

The President announced at a recent press conference that Georgia officials had found means to meet the situation presented by the state's constitutional prohibition against borrowing. Some weeks ago the President said that the state would receive no more PWA grants until some means were found by which the state could guarantee its share of the cost of projects. It is understood that the state legislature will set up a state authority to receive grants from PWA.

(Further news on adv. page 14)

# COMMENT AND DISCUSSION

*Readers' opinions on matters that concern the engineer*

## Plywood Developments

Sir: During the last year or two Engineering News-Record has carried several interesting stories on plywood, the latest being in the issue of Nov. 3, 1938, pp. 548 and 551. We have been particularly impressed by the editorial comments, since it signifies recognition by the construction industry and engineering profession of a material which in the past had been associated more with paneling.

Probably the most spectacular uses of plywood as far as the engineer is concerned have been its application to frame structures in the form of gusset plates built up of many plies of Douglas fir veneer. Of greater importance probably to our industry is the entry of plywood as a structural sheathing material following tests at the U. S. Forest Products Laboratory at Madison, Wisconsin, Stanford University, and other places. We recommend a $\frac{5}{16}$/in. sheathing grade with 6d nails spaced 6 in. on edges and 12 in. on bearings, whereby a rigidity superior to that imparted by diagonal sheathing, long recognized as adequate, is obtained.

As far as glue is concerned, there have been numerous improvements tending toward standardization and economies, as well as structural improvements. All of our stock panels are now manufactured with a water-resistant glue with a soya bean or casein base, or a combination of the two. The new United States Commercial Standard CS45–38 contains for the first time moisture resistance requirements for all Douglas Fir plywood panels, and particularly for the sheathing panels.

We have a special concrete form panel grade where the glue formula is improved from the standpoint of water resistance, but where extra costs are involved both in the glues and in the technique of manufacture. Such panels have been reused as many as 15 times on a number of jobs and while the manufacturers do not guarantee the number of reuses we generally feel that at least 5 or 6 reuses should be obtained even under rather severe conditions.

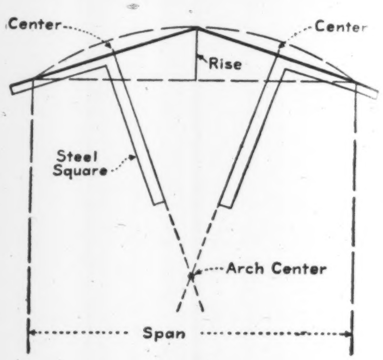
The development of the synthetic resin glues, using the hot plate process, has resulted in a glue line which is generally recognized as absolutely waterproof. We feel that this has been attained by our industry. The combination of heat and pressure with the synthetic resin glues (principally of the phenolic resin type although urea resins are also in the picture), results in a glue line very similar to Bakelite in its composition and one which we have every reason to believe by long experience and severe tests is strictly waterproof.

Glue manufacturers are experimenting with urea resins and cold pressing of urea resins where the use of certain chemicals is involved to induce, under cold pressing, the action now obtained with the hot plate pressing. Various claims for the waterproof qualities of these cold resin glues are made, and the matter is under very careful investigation by our laboratory and by the entire plywood industry in cooperation with the glue manufacturers, but as yet we do not recognize such glues as being waterproof and, accordingly, such panels do not and can not receive the grade-mark and trade-mark stamping "Ext–DFPA" by which we identify the exterior type of plywood. I might add that the association inspection service working closely with all of our association mills maintains a constant and careful supervision of manufacturing processes and of all grade-marking under association symbols.

To sum up, we feel that an absolutely waterproof glue line has already been attained in the manufacture of Douglas Fir plywood by the hot-press, resin-bonded process.

It is interesting to note that tests extending over eight years at the U. S. Forest Products Laboratory on the cold glues of the type used by our industry for stock panels indicate that there is no deterioration in the glue line after continuous exposure to 80 per cent humidity for two weeks and 30 per cent humidity for two weeks in alternating cycles, but that if the humidity is raised to 90 per cent and 30 per cent a deterioration does start. The line of demarkation, or the danger point, seems to be 85 per cent humidity extending over long periods. Such a condition is not attained except in rather extraordinary conditions and in certain manufacturing industries such as paper mills, etc., so that we feel for normal interior exposure all of our stock plywood panels may be considered permanent. By the same token, the water resistance of our sheathing panels is more than adequate, we believe, to withstand even rather heavy soaking during construction operations.

N. S. Perkins
*Manager Engineering Department*
*Douglas Fir Plywood Association*



## Arch Radius

Sir: In the Sept. 8 issue, Daniel Griffith showed the way he would find the radius of an arch. It is a good way, but it would be difficult for a mechanic whose knowledge of mathematics is somewhat limited. Therefore I am enclosing an illustration of a practical way for finding a radius of an arch—one that any mechanic will be able to understand, whether his knowledge of mathematics is limited or not.

A. T. Letendre
*Garden City, L. I., N. Y.*

## Gas Cartridges Aid Dam Excavation

Sir: Referring to your article on the construction of Conchas Dam and the difficulties that had to be overcome to build the abutments against slippery shale faces (*ENR* June 9, 1938, p. 807), it may be interesting to point out that a blasting method new to dam construction was finally resorted to. This method involved the use of Cardox cartridges filled with gas under pressure which, when released, breaks the rock without concussion. Although such cartridges have been used in the mining field, their use at Conchas Dam was something of an experiment since this is believed to have been the first time in the history of dam construction that such a method was used.

On the south abutment, after the top shale layer had been exposed, a tough pink shaly sandstone was encountered. The use of explosives to remove this material not being permitted, since the concussion might affect the stability of the red shale above, the contractor tried various methods of loosening the material, including hydraulic jacks, plugs and feathers, and pneumatic breakers. However, after two weeks of monotonously hard work with unsatisfactory progress, Cardox was tried.

The best results in this pink shaly sandstone, with a maximum shearing and compressive strength of 1,000 and 8,000 lb. per sq. in., respectively, were obtained by drilling holes 6 ft. deep and spacing them 4 ft. apart, 3 ft. from an open face. Where no open face existed, 8 ft. holes were drilled at a 45 deg. angle. When within 2 or 3 ft. of the ultimate foundation, the cartridges were placed in horizontal holes parallel to and within 12 to 18 in. of the bottom. These horizontal charges loosened the material to the final foundation without any appreciable jar or damage. The dam is being built under the supervision of the Corps of Engineers, U. S. Army. This information was supplied to us by C. A. Budnik, of Bent Bros., Inc., & Griffith Co.

**Allyn Harris**
*President, Cardox Corp.*
*Chicago, Nov. 4, 1938*

## Not Service Agencies

Sir: Your news item on exemption of engineering firms from the provisions of the federal wage and hour act on page 745, *ENR* Dec. 15, is not entirely clear. Am I to understand that certain engineering firms are claiming exemption on the ground that they are "service establishments" rather than professional offices? It would seem that, if this is the basis of the claim for exemption, the engineers are placing themselves in the same category with beauty parlors, barber shops, etc.

Is there any reason why engineering firms should not follow the practise of law firms, doctors' offices and others who furnish strictly professional service? Personally I am not concerned with the wage and hour act, but it would seem that, after all the years of striving for professional recognition on the part of engineers, they should continue to seek the same treatment as the older professions.

E. S. Cullings,
*Hydraulic Engineer*
*Watertown, N. Y., Dec. 16, 1938*

It is not probable that engineering firms applied to the Department of Labor for exemption under the "service establishment" exemption of the wage-hour act. They were included by the Administrator along with a long list including legal firms, banks, accountants and stock brokers which had asked the Administrator whether their activities came within the scope of the wage-hour act. What the Administrator did was to tell them all that they cannot expect blanket exemption as service establishments, and that whether they are exempt for other reasons remains to be worked out for each case.—Editors.

## Defying Nature?

Sir: In one of the editorial paragraphs of your issue of Nov. 17 you give a well-merited appreciation of the effect of the Mississippi River cutoffs in lowering flood levels. It may be questioned, however, whether it is not too soon to render a final verdict regarding their influence on the river. So far as I have gathered from the arguments of the pros and cons, it has been generally conceded that shortening the river would reduce flood heights, and certainly no river engineer would deny this. Even that doughty warrior, the late Col. Townsend, long the president of the Mississippi River Commission and a rock-ribbed defender of the river's natural rights, frankly admitted, I have always understood, that a shortened course would reduce them. The method in fact has long been a favorite solution of the flood problem among the lay brethren, and periodically would find lodgment in the brain of some congressman who thereupon, conceiving it to be a totally new idea, would gleefully approach the commission and expound the new discovery. It then became necessary to explain to him, gently, patiently, and with the courtesy we should always show to congressmen, that to carry out his idea would be very expensive (which interested him but little), and that it was also open to serious engineering objections (which interested him not at all).

The basic question at issue has not been whether or not flood heights would be reduced, which was always the easier part of the problem. The real crux of the matter is whether or not the lopping away of a third of the river's course, reducing it from 331 to 215 mi., and increasing proportionately the swiftness of the current, will start the river on a fight to regain the lost mileage, with consequences to riparian property and lands which may well become disastrous. Nature having established through unknown centuries a balance between length and slope of bed, or, to put it in another way, between the material of the bed and the swiftness of the current, it is reasonable to question if the drastic upset of this balance will not generate an effort by the river to restore its former regimen. If it does, not only will the benefits of the cutoffs disappear, but changes are liable to result which will make the last state, like that of the sinner in the parable, worse than the first. As one engineer said to me: "We all know that water tries to run downhill the shortest way it can. So it is reasonable to theorize that every alluvial river, in a life perhaps counting thousands of years, ought to carve for itself a straight channel. But as none has ever done so, there must be compelling reasons why it has never happened. So isn't it a good deal of a gamble to try to make Nature do something she has always and everywhere refused to do?"

The new cutoffs now seem about ready to start capacity production, but it will probably be several years before any marked tendency appears, if it does appear, towards a regaining of the former mileage. With rivers such as the Indus, which has been known more than once to engulf several villages in a single flood season, conclusions one way or the other would become available in a short time, but with a river of the size and more stable regimen of the Mississippi, it is reasonable to believe that much more patience will be required.

*(Continued on adv. p. 18)*

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*DECEMBER 29, 1938*

A change in the publishing schedule of Engineering News-Record will be inaugurated with the first issue of 1939. Interested readers are referred to an advance announcement on the contents page of the present issue.

## *Into a New Year*

A DIFFICULT YEAR draws to a close. Its material results are decreased production and increased waste of human resource, manifested in additional unemployment. But while it disappointed many hopes, it brought some encouragement by showing that industrial and business enterprise possesses unexpected elasticity under depressive influences. Moreover, it witnessed a return to order and sanity in the country's thinking, and a decline of faith in isms and expedients. Hard work, creative effort and upright dealing once more gained recognition as motive forces of progress. The new year therefore opens with good promise; recovery from the long depression has already been resumed. However, the great problem of repairing the wastes of nine years remains, and at best, therefore, the rebuilding will be a gradual process. That construction is well prepared to play its part in the work has been demonstrated by its steady gain during the past year against the backward current of declining industrial production. If in its further advance during the coming year construction succeeds in attaining some measure of greater efficiency—not least in providing better housing for the people—it will make a definite contribution to sound and lasting recovery.

## *Well-Deserved Tribute*

WARM APPROVAL will greet the bestowal of the Hoover medal on John F. Stevens, organizing genius of Panama Canal construction. While the medal cannot confer distinction on one whose fame rests on great engineering achievements, it supplements the honors heretofore bestowed on Mr. Stevens by singling out a performance of exceptional rank. His contribution to the Panama work was decisive, and but for it the history of the undertaking might have been very different. By planning the job, by building an organization, by creating the methods and giving the work its momentum, he set in motion what George W. Goethals completed. At Panama the broad grasp and sound judgment which he developed in earlier years of exploring mountain passes and building and operating large railway systems came to fruition in coping with the prodigious physical and human problems of the Isthmian canal project.

## *Meanders and Cutoffs*

FIRMLY EMBEDDED in traditional river thinking is the doctrine that a river desires to be just so long and that a shortened river will try to regain its length, while a river of "natural length" is stable. A correspondent in this issue cites the doctrine to support a doubt as to the permanence of the Mississippi River cutoffs. Unquestionably the doubt itself is legitimate, since nothing about the alluvial Mississippi has ever been stable unless held; the infinitely marked river bottoms tell a clear story of how the river has swung across its valley time and again in every mile of its course. But this very fact means that the river was never stable even though left free to adopt is natural length. Would it have been less stable if made shorter? The argument that a shortened stream has too much eroding power to maintain a straight course is belied by the fact that rivers of steep fall are usually rather straight, while sluggish rivers are the ones of greatest sinuosity. Observation thus suggests that deficiency rather than excess of carrying power is the source of channel instability. If this is so the existence of "natural" meanders cannot successfully be made an argument against cutoffs.

## *Pocket-Size Drawings*

REDUCING DRAWINGS from original size to pocket format has been advocated for many years and practiced often enough to prove its practicability and value, yet it remains infrequent practice. E. L. Sanders' report of Colorado Highway Department methods is therefore valuable. Thirty years ago the late Morris Knowles adopted the reduced-drawing system when building the Pittsburgh filter plant; to see him go over the job with a full set of detail drawings reduced to 8 x 10 in. sheets of thin photoprint paper, bound in a small folding case that fitted his coat pocket, was a revelation to anyone who ever had wrestled with a large roll of blueprints to find a needed dimension. That despite its advantages the system has not come into general use must be attributed to failure to realize that it requires few precautions beyond adequate line spacing and line strength plus properly proportioned lettering. But to permit of observing these precautions it is necessary to resist the common tendency to overcrowd a drawing. Good judgment in laying out the schedule of drawings for a job is therefore necessary. Such judgment, however, will pay dividends in elimination of errors even when reduction of the drawings is not contemplated.

### *New Bridges for Old*

ANOTHER REMINDER that one of the most notable bridge modernization programs on record is under way in New York City was continued in last week's announcement of the opening of a new upper roadway on the Queensboro bridge. This structure and the other principal East River crossings—the Williamsburg and Manhattan bridges—have been carrying in excess of 200,000 vehicles a day, far above the capacity for which they were designed. That the bridge engineer is able now to fit them to the demands of modern service is generally taken for granted, but it is nevertheless an achievement to be proud of. Each bridge has presented a different problem, but basically the job has been to provide new vehicle roadways of smooth and non-skid type and also of reduced weight so that live-load capacities can be increased. In this task the engineers were aided by the fact that main carrying members were generally strong enough for the modern loads, a fortunate condition which engineers the country over have often encountered on old bridges that required modernization. Solid slabs cast in place and precast slabs of concrete-filled steel grid type have been used on the Queensboro and Manhattan bridges, while for the Williamsburg bridge a lightweight open-grid floor is said to be planned. When all of this modernization work is complete next year New York's famous old East River bridges—except the Brooklyn bridge, oldest of all—will be new again for another indefinite period.

# Help for the Railroads

LAST WEEK there was laid before the President a report of a committee appointed to study the predicament of the railroads and to recommend what should be done to put them back on a sound operating basis. The railroads normally are such large and diverse spenders that the country cannot expect to get back to normal while rail transport is in such a bad way. Hence the proposals now before the President have wide significance. The construction industry is especially concerned, for in normal years the railroads spend $500,000,000 on construction.

From the long-range viewpoint, most important of the committee's recommendations is that Congress adopt a definite transport policy which will provide for equal treatment of all forms of transportation—rail, highway, waterway and air. All transportation development would be placed under the supervision of a new agency, a transportation board, which would take over many of the functions now exercised by the Interstate Commerce Commission. It would lay down regulatory provisions for all forms of transportation so that the inherent advantage of each would be preserved and yet all would be under equal regulation. One of its first tasks would be to determine the extent to which the railroads' competitors are subsidized by the government and to report on needed legislation.

Subsidies, open or hidden, are responsible for much of the present condition. Most flagrant is the subsidy to waterway transportation. The government builds and maintains our inland waterways and the carriers by water pay no toll for their use. Whether the commercial carriers by highway also are subsidized is less clear because of the fact that both commercial carrier and private vehicle use the same highway and together they pay more in gasoline taxes and license fees than the government spends on roads. But the highway carriers have been heavily favored through failure to require them to live up to working and safety rules on a par with those set up for railroads. Such regulation is now being evolved by the I.C C., but as yet there has been no effort to determine which of the limitations imposed on railroads should be removed.

To meet the present emergency the President's committee makes numerous recommendations, most of which have been put forward previously and are widely approved. Of special importance is the proposal to set up a reorganization court of special judges which could speed up the many reorganizations now in process or in prospect, the I.C.C. to be relieved of all responsibility for reorganization.

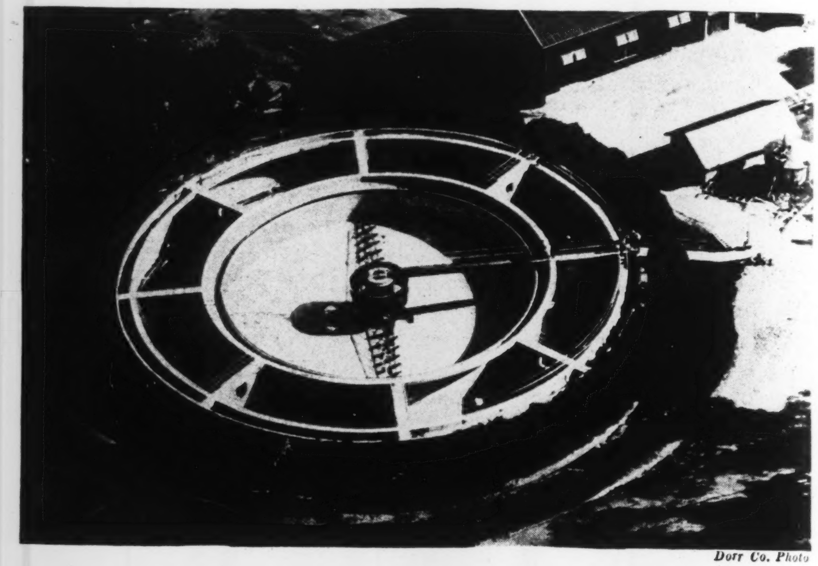
Also important is the recommended abandonment of the present requirement that any consolidation of railroad companies must be in line with an approved plan prepared by the I.C.C. The impracticability of the present law is now all to obvious, yet much benefit could be derived from the elimination of many small companies and a logical grouping of the remaining ones. But little will be accomplished unless Congress permits the railroads to make consolidations which will eliminate needless jobs.

Other recommendations include the charging of tolls on inland waterways and freeing railroads from sharing in the cost of work made necessary by waterway or flood-control projects and highway crossing eliminations.

At best the reestablishment of our railroads on a stable foundation will be slow, and some of the steps must be drastic. The change must come soon if we are to save that part of our investment in railroad properties that should be saved and at the same time check the uneconomic investment of funds in transportation agencies having no sound economic justification. No problem before the incoming Congress is more important; none calls for greater statesmanship.

# PICTURES IN THE NEWS

*SYMMETRY in sewage treatment. This "Currie Claraetor," a recent development in activated sludge plants, for small cities is located at the Tri-City sewage treatment works, which serve Alhambra, Pasadena and South Pasadena, Calif. The annular segments are aeration tanks, and in the 78-ft. central tank is a clarifier. The unit was developed by Frank Currie, San Bernardino consulting engineer.*

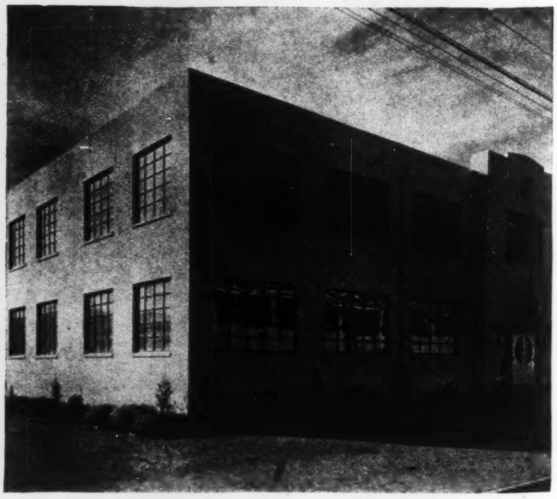


Dorr Co. Photo

*EARTHMOVING INDOORS. (left) Following the annual Horse Show at Madison Square Garden, New York, it was necessary to remove 800 cu.yd. of earth in four hours so the floor could be prepared for hockey games. The grader shown, and another, did the job without damage to the floor.*

Caterpillar Photo

*DOUBLE TRANSPARENT WINDOWS enable workers in this Westinghouse building at Emeryville, Calif., to see outdoors and at the same time enjoy air-conditioned insulation from the vicissitudes of weather.*



# Design of a 400-ft. Octagonal Tower

JOHN J. GOULD

Chief Structural Engineer, Golden Gate International Exposition

*"Tower of the Sun" at the 1939 San Francisco Fair, whose design was determined largely by wind load requirements, has a vibration period of 1½ sec.*

OUTSTANDING among structural features of the 1939 Golden Gate International Exposition on San Francisco Bay (*ENR* Oct. 13, 1938) is the 400-ft. central tower: "Tower of the Sun". Octagonal in plan, this tower has an outside diameter of about 59 ft. and a structural framework of a design controlled by architectural effect and wind resistance. Exterior finish consists of ½ in. of plaster put on 1x6-in. sheathing without the aid of the usual wire mesh; in lieu of the mesh each board has grooves which form keys for the plaster.

Unsupported columns 100 ft. long in the central portion of the tower and the fact that the structure had to be supported on a new fill on soft bay bottom were factors in the design. Wind loads were assumed to be 15 lb. per sq. ft. for the lower 60 ft. of the tower and 20 lb. per sq. ft. above that level. To provide torsional rigidity an unbalanced wind load of 5 lb. per sq. ft. was figured on one-half the tower diameter. These requirements were met and the desired architectural effect were attained by making the foundation plan much like the plan of the tower itself; that is, the eight columns are carried down directly to an octagonal concrete base.

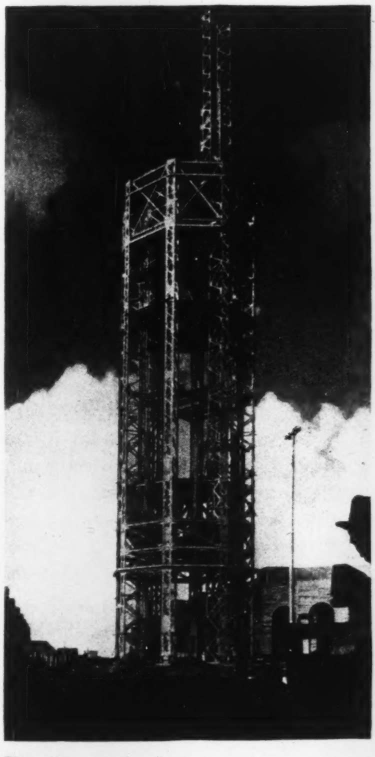


**Fig. 1.** Erecting structural framework for "The Spire of the Sun."

## Foundation in new fill

The tower had to be built on a newly reclaimed area in which mass subsidence might occur. Piles 90 ft. long were used because borings indicated that that length would go through various soft and hard layers and the tips would extend sufficiently into a firmer sand stratum. The foundation plan was shaped like a wheel 65 ft. in diameter with eight spokes and a rim of the same width and depth as the spokes, as shown in Fig. 2. This plan avoided crowding the piles (although a total of 212 were used) and in the rim, as well as in the spokes, only two rows of piles were required. With this spacing it was expected that skin frictional resistance would be increased by an enlarged pressure cone at pile tips, thereby transferring loads to a greater subsoil area. The advantage of this plan seems to be demonstrated by the small amount of settlement. When the tower was practically completed the total subsidence was only 1½ in. and was uniform.

In the superstructure, unit stresses were kept within the 1934 specifications of A.I.S.C. except in the long, unsupported columns (El. 73 ft. 10 in. to El. 178) and here no increases were allowed over basic stresses in figuring wind loads. Elsewhere, for a combination of wind and dead loads, plus secondary stresses caused thereby, an increase of one-third was allowed over the usual working stresses.

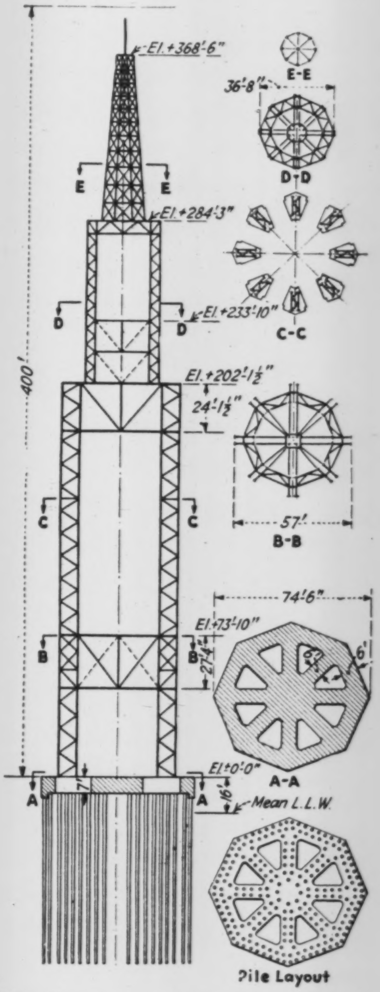


**Fig. 2.** Plans and elevation show the structural scheme.

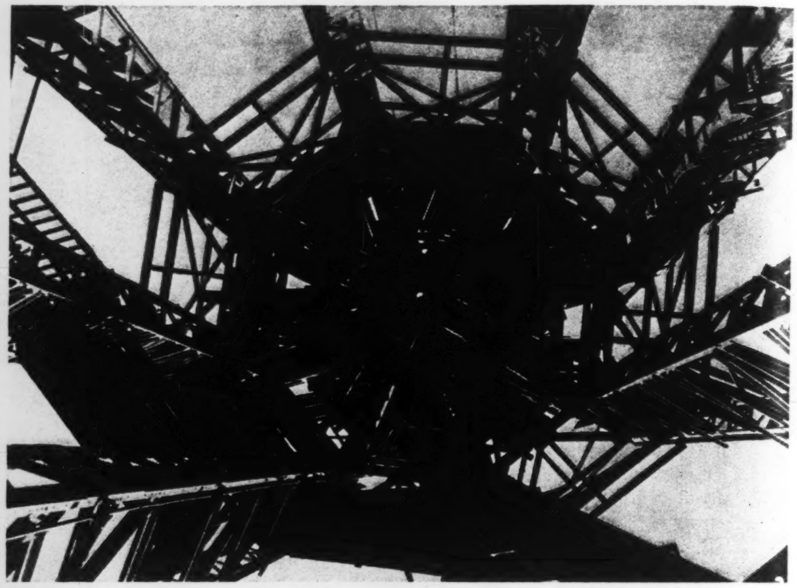


Fig. 4. Looking up into "spider webs" at the upper end of the unsupported 104-ft. columns. This view shows K-frame details.

Horizontal wind loads on the tower totaling 300,000 lb. were transferred to the ground through the piles with vertical loadings per pile not more than 25 tons and without assuming any tension in piles. Because the vertical load on the concrete base is only 3,000,000 lb. and the overturning moment, caused by wind, is 50,000,000 ft.-lb., each of the main steel columns was anchored to the concrete base by ten $2\frac{3}{4}$-in. bolts.

Wind loads, the governing factor in the determining stresses in tower members, were somewhat more difficult to handle by reason of the small tower diameter. The great length of unsupported main columns (104 ft. 2 in.) made it necessary to resist wind stresses by a series of rigid frame bents on radii corresponding to the spokes of the wheel in the foundation plan. The main columns are 4x9-ft. in plan and each consists of four legs made up of two heavy angles. At the various platform levels the main columns are interconnected radially with horizontal and diagonal struts forming a vertical K-frame. To facilitate erection and to simplify details the diagonals of the K-frames were reversed in pairs at the first platform (El. 73 ft. 10 in.) and on the second platform (below El. 202 ft. $1\frac{1}{2}$ in.) only one pair of diagonals was used.

Provision for wind load of this order gave more structural resistance than would be necessary to resist seismic forces of 0.1 g. Moreover, a slender tower of this design naturally has a considerable degree of flexibility which would considerably reduce the transfer into the structure of seismic shocks.

Maximum wind stresses in the main columns occurred 75 ft. above the ground. Of the total stresses here 15 per cent were caused by dead load, 10 per cent by deflection of the structure and 75 per cent by wind load. Computations of the tower top deflection under wind loads of 15 to 20 lb. per sq. ft. gave a total of 20 in. This included 7 in. resulting from lengthening and shortening of the columns, $11\frac{1}{2}$ in. from bending deformations and $1\frac{1}{2}$ in. from shear deformations in the main column widths.

Two vibration tests made with U.S. Coast & Geodetic Survey instruments at El. 286 at a time when the exterior sheathing and studding was as shown in Fig. 3, indicated that the period was $1\frac{1}{2}$ sec. in both directions. On the two occasions when measurements were taken the

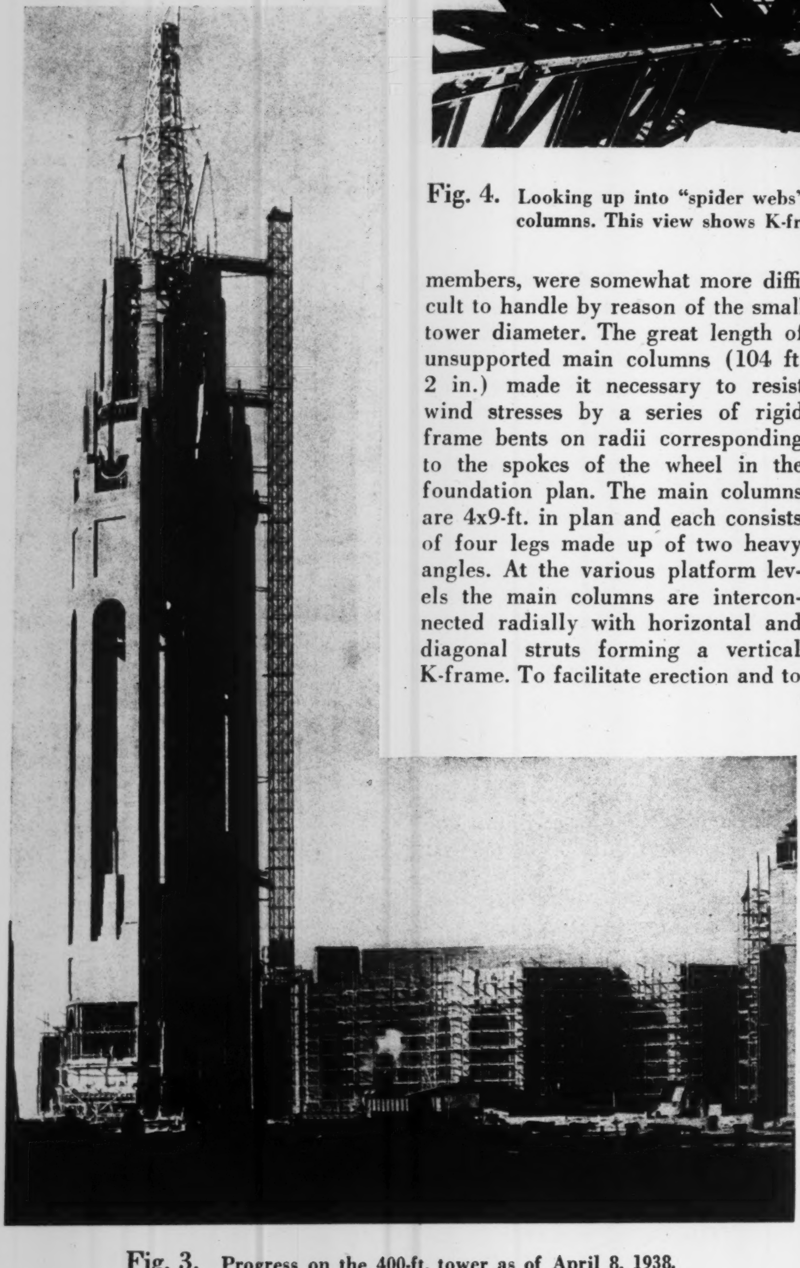


Fig. 3. Progress on the 400-ft. tower as of April 8, 1938.

periods checked closely. (Instrumental work by F. P. Ulrich and D. C. Carder of the U. S. Coast & Geodetic Survey).

The natural vibration period was computed by the method described by Prof. L. S. Jacobsen, Stanford University, in April *Proceedings*, Am. Soc. C.E. Considering the tower as a cantilever, the period was found to be $T = 0.258\sqrt{\text{Deflection } A} = 0.258\sqrt{46 \text{ in.}} = 1.74$ sec. Deflection $A$ is the computed deflection of the tower loaded with its own weight.

Using weights of the structure for the stage of completion at which the instrument readings were made, the calculated period was found to agree very closely with that read by instrument. It is to be noted that in determining these periods the amplitude measured by instrument is that of the natural vibration resulting from the elastic properties of the tower excited by wind gusts. This amplitude of 2 to 4 mm. is a dynamic displacement with respect to a deflected tower in which certain deflection has already resulted from steady wind pressure.

Additional vibration tests are to be made after completion of the tower and installation of the heavy bells that are to be located in it. A 5-ton bell is to be mounted at El. 73 ft. 10 in. and a 44-bell carillon weighing 20 tons is to be put at El. 233 ft. 10 in. The test is expected to indicate whether operation of the carillon will affect the tower period. After the exposition, bell and carillon are to be permanently located in the tower of Grace Cathedral in San Francisco.

Structural steel in the tower, which totalled 880 tons, was erected principally with gin poles. The long-columns were erected with the aid of working platforms put in at about 35-ft. intervals.

W. P. Day is vice-president and director of works of the Golden Gate International Exposition and H. C. Vensano is chief of construction. Architectural design of the tower was prepared by Arthur Brown, Jr., chairman of the exposition's architectural commission, and E. L. Frick, chief of the division of architecture of the department of works; the structural design of the tower was prepared under the direction of the writer. The Guy F. Atkinson Co. is general contractor on the tower and the Judson Pacific Co. fabricated and erected the structural steel.

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# Hydraulic Jump In Enclosed Conduits

E. W. Lane and C. E. Kindsvater

Iowa Institute of Hydraulic Research, University of Iowa, Iowa City, Iowa

*Laboratory tests show that the momentum theory of jump applies to irregular and enclosed conduits*

Occasionally the hydraulic engineer finds it necessary to investigate the action of water flowing at high velocity in a partly filled enclosed conduit. Under certain conditions a hydraulic jump may be formed. For example, a jump is likely to occur when water from behind a high dam is discharged through a spillway or outlet tunnel, if the lower end of the tunnel is submerged by high water.

While the theory of the hydraulic jump is well developed (*ENR* Nov. 25, 1920, p. 1034 and *Technical Report Part III* Miami Conservancy District) and close agreement has usually been found between theory and observed conditions in open rectangular channels, very little information is available on the jump in channels of other shapes, and so far as known, no tests have been previously made in enclosed channels. Moreover, experience has shown that quite unexpected hydraulic phenomena of a secondary nature frequently occur when hydraulic structures are designed on the basis of theory alone, but that the existence of these actions could have been shown by laboratory tests.

In order to demonstrate the reliability of the commonly used theory of the hydraulic jump, when applied to the enclosed conduit, as well as to discover any such secondary phenomena involved, the experiments described herein were recently carried on at the University of Iowa.

### Laboratory set-up

The experiments were made in a 6-in. transparent celluloid pipe. The high velocity and partial depth of flow necessary to form the hydraulic jump was produced by introducing constrictions in the pipe (Fig. 1) which produced a stream of water along the bottom of the pipe with a supercritical velocity and level upper surface. Three different constrictions were used, extending down from the top of the pipe and closing off respectively 0.4, 0.6, and 0.8 of the diameter.

The discharge of water was regulated by a valve in the supply pipe connecting the upper end of the transparent pipe to the laboratory

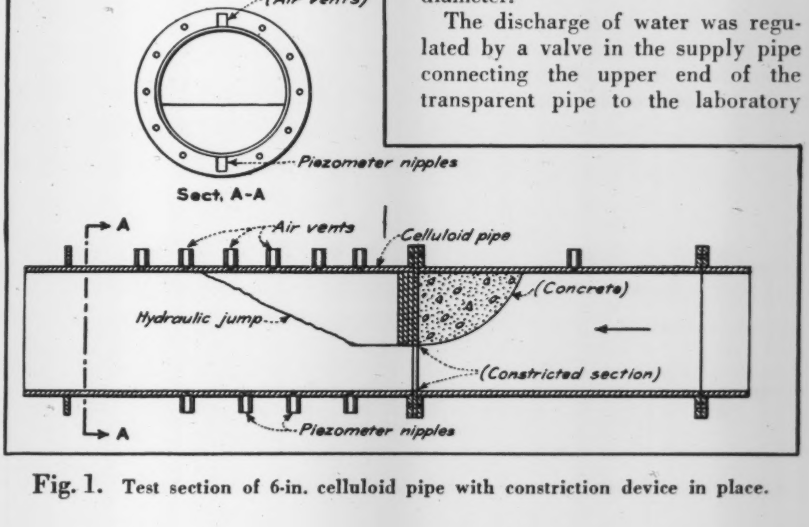

**Fig. 1.** Test section of 6-in. celluloid pipe with constriction device in place.

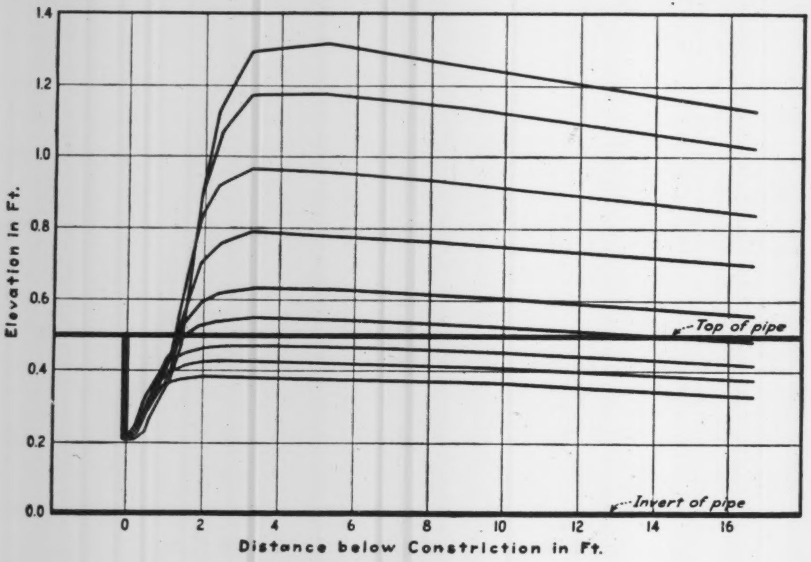

**Fig. 2.** Profile of piezometric levels below constriction obstructing 0.6 of the depth.

constant-level tank, and the conditions of flow downstream from the jump were controlled by a valve near the end of the pipe 20 ft. below the constriction. Piezometers were placed in the pipe at intervals above and below the constriction, being closely spaced in and near to the section of the pipe occupied by the jump. Air vents were also placed in the top of the pipe just downstream from the constriction.

With a given constriction in place, various discharges were introduced into the upper end of the pipe and forced to flow through the constriction, each flow producing a different velocity but the same depth immediately below the constriction. The valve near the downstream end of the pipe was then regulated until the hydraulic jump formed just below the constriction. After the conditions of the flow had become constant the water levels in the manometers along the pipe were observed and the discharge was determined by means of a gravimetrically calibrated 90 deg. V-notch weir. In all, 35 different conditions were studied.

### Conditions affecting jump

For the lower discharges the height of the jump was not sufficient to fill the entire pipe and the condition was that of flow in an open conduit of circular cross section. For higher discharges, however, the jump entirely filled the pipe and pressures were exerted on the top. In Fig. 2 is shown the piezometric level of the water below the constriction obstructing 0.6 of the depth down from the top of the pipe, for various discharges.

When the jump fills the pipe the access of air from downstream is shut off and the air which is mixed with the water by the turbulent action of the jump is carried away downstream as bubbles in the water. Unless some source of air is provided, a vacuum will tend to form in the space just downstream from the contraction. This increases the effective pressure downstream from the jump and usually causes the jump to move upward and fill the space in the pipe behind the constriction, thus submerging the jump.

If the velocity of the entering stream is high enough, however, the highest vacuum that can form (the pressure at which the water will vaporize and fill the space) will not be sufficient to cause the jump to move upstream and the jump will occur in a nearly complete vacuum. (The limitations of the apparatus prevented the occurrence of this latter condition and the proof of its existence is based on reasoning rather than experiment.) The formation of a jump under such conditions is likely to set up vibrations and cavitation and, therefore, is very undesirable.

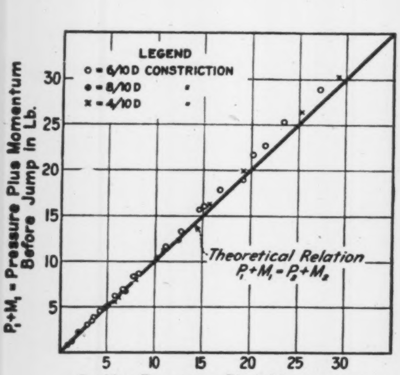

**Fig. 3.** Theoretical and observed values of pressure-plus-momentum.

It is believed that this phenomenon is the explanation of the undesirable conditions which have occurred in certain high-head outlet works. To prevent such conditions an ample supply of air must be admitted below the contraction. Since no data are available on how much air is required, the supply provided should be liberal. If the vent capacity is not sufficient to keep the pressure immediately downstream from the contraction up to atmospheric, the reduction in pressure must be taken into account in computing the action of the jump.

### Results check theory

According to the well known theory of the hydraulic jump, which neglects side and bottom friction in the jump, the pressure of the water on a cross-section at the beginning of the jump, plus the momentum of the water at that point should equal the pressure plus the momentum at the end of the jump. The experimental results agreed substantially with this criterion, as shown in Fig. 3.

The pressure-plus-momentum on the upstream side of the jump was slightly greater than that on the downstream side. The major part of this excess was probably due to the side friction in the section of pipe occupied by the jump, which could not be accurately estimated. Another part was due to the lack of uniformity of the velocity distribution below the jump, as was assumed in computing the momentum at that point. A third part was due to the fact that the momentum computations neglected the air bubbles in the water in computing the velocities below the jump. The velocities were computed by dividing only the discharge of water by the area of the pipe, instead of using the combined discharge of water and air. As computed the velocities below the jump are therefore too small, hence the momentum is also too small. In general, the results indicated that the commonly accepted momentum theory of the hydraulic jump can be applied to channels of irregular shape and to the hydraulic jump which takes place in an enclosed conduit.

Acknowledgment is made of the assistance of the late D. L. Yarnell and of Prof. C. J. Posey in conducting these experiments.

# Strictly Handmade

Fu-Hua Chen
Designing Engineer, National Economic Council, Republic of China

***Picks, shovels, watering cans, hand pulled rollers and muscle do a job of soil-cement roadbuilding***

On the old Sian-Lanchow highway laid out about 900 A.D. the National Economic Council of the Republic of China has built some 18.65 miles of cement processed earth road as a part of its plan to pave all the 472 miles. All the work was done by hand and some of the methods used may interest American road engineers who have carried this type of construction to such a high degree of refinement.

The roadbed was excavated to a depth of 6 in. by picks and shovels. The width of the existing road was 30 ft. and a trench was excavated along the center, about 10 ft. in width which was sufficient to carry single-lane traffic. All soil used was taken from the road shoulder and screened through a ½-in. screen. The screened soil was then uniformly spread in the trench to a depth of 9 in.

Cement was added to the soil through a fine mesh sieve at the rate of 375 lb. per 11½ ft. for the entire depth. Mixing was done by men with shovels and rakes which turned the soil-cement mixture over and over many times until the cement was uniformly mixed with the soil. Water was then added at a percentage slightly below the optimum moisture content. The moisture content of the dry mixture was first determined, then the water necessary to bring the moisture content to 18 per cent was calculated. The required water was measured and stored in big barrels placed along the road. Then water was taken from the barrel and spread into the soil-cement mixture by sprinkling cans.

Wet mixing was done in the same manner as the dry mixing, and was continued until the lift had uniform color. After the lift was uniformly mixed and shaped, it was rolled by a 3-ton roller pulled by a number of laborers. Rolling was continued until a smooth and hard surface was obtained. The finished road was opened for traffic after 72 hours.

During the process of mixing, the lift was divided into separate units. Each unit was 23 ft. long. Twelve laborers to a unit were used: six with shovels, four with harrows and two for spreading cement and sprinkling water. The entire process of mixing was completed within one hour by trained laborers. The length of section was 26 to 30 units, or 600 to 700 ft. Each section was completed before the other began. The joint between sections was carefully connected by skilled laborers, so that a smooth joint was obtained. No attempt was made to provide joint filler. Three hours were required for rolling each section. After rolling, if the temperature was high and evaporation rapid, the finished road was covered with a layer of earth. This seemed to reduce the number of shrinkage cracks.

About 150 heavily loaded trucks, 200 horse-drawn vehicles and 200 hand-pushed carts are carried by the road each day. Loaded trucks cause no damage to the pavement provided they do not carry chains; steel-tired horse-drawn vehicles and hand carts are chiefly responsible for pavement wear.

The wage scale was 60 and 70 c. (17 and 23 c. U. S. money) per 10-hr. day for semi-skilled labor, such as mixing and 50 c. (14 c. U. S. money) per 10-hr. day for ordinary labor. The cost of cement per barrel is about $10 ($2.86 U. S. money) including delivery charge. The cost per square yard in U. S. money was:

| | |
|---|---|
| Labor and equipment | $0.108 |
| Cement | 0.182 |
| Total | 0.29 |

The work was carried out under the direction of the writer.

Men with sprinkling cans filled from barrels do the work of water trucks on a cement processed soil road in China.

# Designing Workable Concrete

C. A. G. Weymouth

Raymond G. Osborne Bureau of Tests, Los Angeles, Calif.

*A method of combining sized coarse aggregates to secure workable concrete without raising the water-cement ratio*

Complete workability of mixture was secured by the method described here in placing 50,000 cu.yd. of concrete for the new union passenger railroad terminal at Los Angeles, Calif. The building elements varied from massive foundations to thin wall and floor slabs that were often heavily reinforced. The mixes used were not unusual, varying from 1:4½ to 1:6.6 by weight or roughly from 6½ to 5 sacks per yard. Some of the mixes for backfill were as lean as 1:12 and 1:16, but all, even the leanest, were made workable.

Except that the aggregates were graded, as is specified later on, neither materials nor methods of mixing and placing were unusual. The high degree of workability, essential because of the pouring conditions, was secured by controlling sand-cement ratios, by using fines in lean mixes to replace some of the cement and especially by combining sized coarse aggregates. The sized aggregates used were: No. 4 "pea gravel" between No. 4 and ⅜-in. sieves (square openings); No. 3, "three-quarter" gravel between ⅜ and 1-in. sieves; No. 2, "inch-and-a-half" gravel, between 1 and 1½-in. sieves.

## Placing conditions

Some conditions considered in designing mixes were: (1) The size of bars and their spacing; bars are more closely spaced than in buildings in other parts of the country to resist the effects of earthquakes; (2) size and shape of section to be poured; (3) method of placing, as by chute, tremie, direct pour from buggies and from transit mixers; (4) the maximum size of aggregate which could be used; (5) characteristics of cements, several brands being purchased from different companies; (6) the necessary consistency; (7) possible variations in the grading of fine and coarse aggregates.

Usually the mix was not designed until the forms were ready, so that no condition would be overlooked. All concrete was placed by vibrating; the speed was 8500 r.p.m. under load. All forms were more strongly built than for hand spading, and for stiff mixtures the intensity of vibration was reduced by lowering the voltage from 110 to 80, to avoid injury to forms.

In the beginning, 1-in. to 2-in. slump consistencies were used, but it was found to be better to use mixes of greater slump to speed up the placing since the standard hopper throats and chutes would not handle the stiffer mixtures. Vibration with high slumps (4-7½-in.) did not cause the coarse aggregate to settle in an arched condition because of the cohesive effects of the fine sand. On pitched roof slabs, a 3½-in. slump was considered sufficient for finishing. A 6-in. slump was used for pouring through small tremie throats and in closely spaced column spirals, and a 7½-in. slump was used where concrete was inaccessible for vibrating or spading.

Plywood and Celotex lining were much used for wall forms. Apparently the absorption of the surface water by the Celotex gives a surface free from crazing, but the vibrating had to follow the pouring closely lest the concrete in contact should become firm before the forms were filled.

No trial batches were made, but trial mortars were made in the laboratory at the beginning, and a mortar-voids curve was plotted for mortars which would make concrete with a 6-in. slump. Thereafter, so long as the same sand was used, trial batches were unnecessary. When the sand was changed the mortar-voids curve was determined by new tests. The mortar-voids curve is made by the method of Talbot and Richart, but where their curve is based on tests of mortars mixed to maximum density, the writer uses a consistency that will give a 6-in. slump to the concrete. This is determined by a 3½-in. flow in a 3-in. Burmister flow trough with ten 1-in. drops, all the dimensions being one-half of those of the standard trough. For highway work poured with stiffer concrete, a smaller consistency, like a 2-in. slump, should be used in the mortar-tests. The values of "Gal. per Sack" in the accompanying diagram apply only to 6-in. slump concrete using sand of angular grains.

Mortars are designed from the diagram. Let it be assumed that 6-in. slump concrete is wanted, made with Sand E using 6 gal. per sack. From the point on the diagram where the 6 gal. line crosses the line of the E-sand a perpendicular is dropped to the base to find a/c, the sand-cement ratio, 2.72.

The absolute volume of 1 sack of cement is 0.48 cu. ft. so the absolute volume of the required sand would be 2.72x0.48, or 1.306. The water, 6 gal., is 0.803 cu. ft., so ~~for 1~~ sack of cement the mortar would be:

| | |
|---|---|
| Cement | 0.480 cu. ft. |
| Sand | 1.306 cu. ft. |
| Water | 0.803 cu. ft. |
| | 2.589 cu. ft. |

The absolute volume of the coarse aggregate may be assumed or calculated. In either case it will be necessary to calculate the combining of the aggregates to obviate particle interference, so the method of doing this will first be explained.

## Particle interference

Particle interference is the condition that results when too much of the aggregate is in one size-group; a size-group being the fraction retained between two adjacent sieves of the series used for the sieve analysis of aggregates, as between No. 4 and No. 8 or between the ⅜-in. and ¾-in. sizes.

The material in a size-group is in excess when the average clear space between its particles is less than the diameter of the particles in the size-group retained by the next smaller sieves. Thus, if the size-group to be examined were ⅜-in. to ¾-in. the average clear distance between the particles (as they are positioned in the concrete) must be greater than the average diameter of the No. 4 to ⅜-in. grains.

Where there is no particle interference the smaller grains can pass freely between the larger grains to distribute themselves evenly throughout the mass, making a homogeneous mixture of extreme workability. Where grains of one size are in such excess as to cause particle interference, these particles will form bunches and the mix will be non-homogeneous making a weak structure with large local voids from which the water will leak.

The average clear distance between the particles in a size-group is determined by the formula:

$$t = \left[\frac{d_o}{d_a}{}^{1/3} - 1\right] D$$

where $t$ is the distance to be found. $d_o$ is the density (the percentage of the total volume occupied by the solids) of the particles of the size group in a dry rodded condition, and $d_a$ is the *relative* density, that is the solidity ratio of this group relative to the space available to it. The available space for any size-group is the total volume of the concrete less the volume of the particles larger than those of this size-group. $D$ is the average diameter of the particles of the size-group.

Since $t$ varies with $d_a$ it is sufficient to compare the value of $d_a$ with the highest value which $d_a$ may have without causing particle interference. This critical value of $d_a$ is found by the formula:

$d_a = .296 \times d_o$ (for ordinary continuous gradings) where $d_o$ is constant for any given aggregate, varying from 0.580 for angular grains to 0.650 for rounded grains. For Los Angeles gravels it is 0.615. Hence the critical limit of $d_a$ used in designing the Terminal concrete is $0.296 \times 0.615$, or 0.182.

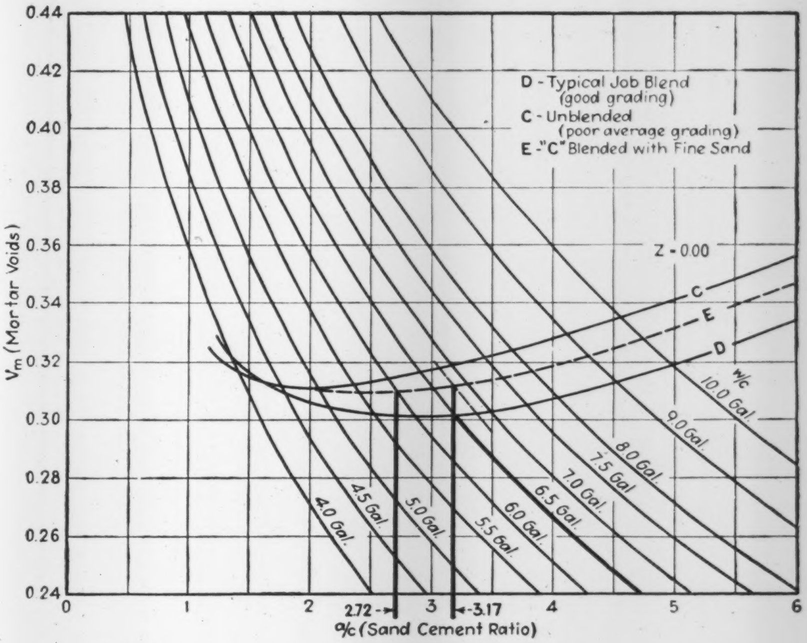

**Fig. 1.** Mortar-voids curve chart for sands with angular grains.

Gradings of the coarse aggregates as delivered are shown in the upper portion of Table I, no No. 2 gravel being used in this first example. The decimal fractions of absolute volumes in the table represent the amounts of gravels, Nos. 3 and 4, contained in a unit volume of the final concrete mixture after combining with the mortar selected above. While the explanation may seem long, the actual computation required is much less, for example, than that required to fit sized products to a grading curve.

In computing, the effort is made to keep the size-groups full, that is, to have as much material in each of them as possible without making the relative density of the size-group, $d_a$, greater than the critical value of 0.182. The factors which give the amount of each sized product are found by trial and error, and the coarsest size-group is figured first. In this case the amount of the coarsest size (32.1 per cent) is less than the amount in the next size-group (53.7 per cent) so the factor must not be too large. Visual inspection shows that the factor for No. 3 gravel should be about 0.300. The percentages as decimal fractions, of the size-groups in No. 3 gravel are multiplied by 0.300, giving the results in the first line below "Absolute Volumes" in the table. The abs. vol. for the ¾-in. to 1-in. group is 0.300 × 0.321, or 0.096. Subtracting 0.096 from 1.000, the total volume of the concrete on a unit basis gives 0.904 as the available space for the next size-group, ⅜-in. to ¾-in., of which there is 53.7 per cent. Then 0.300 × 0.537 is 0.161, and this is close to .164, (0.182 × 0.904), which the slide rule shows to be the limit, in order that $d_a$ may not exceed 0.182. But there is only a very small percentage of ⅜-in. to ¾-in. in the No. 4 gravel, so the factor, 0.300, may be used.

For the next size-group, we have 0.116 × 0.300, or 0.035, in the No. 3 gravel. There is 3.9 per cent of this size (No. 4 to ⅜-in.) in the sand, and this must be multiplied by the unit volume of the sand. Experience with other mortars of this kind tells us that this will be about 0.300 so this is used, and a correction may be made later if necessary. In this case the final addition shows it to be 0.298,

**Table I—Computation of Volume of Coarse Aggregate**

| Aggregate Sizes | 8–4 | 4–⅜ | ⅜–¾ | ¾–1 |
|---|---|---|---|---|
| | | Grading | | |
| | PC | PC | PC | PC |
| No. 3 | 2.6 | 11.6 | 53.7 | 32.1 |
| No. 4 | 16.0 | 81.0 | 3.0 | ..... |
| Sand E (Coarse portion) | 11.0 | 3.9 | ..... | ..... |
| | | Absolute volumes | | |
| No. 3 $b^3 = .300$ (73.5%) | .008 | .035 | .161 | .096 |
| No. 4 $b^4 = .108$ (26.5%) | .018 | .087 | .003 | ..... |
| Sand (assume .300) | .033 | .012 | ..... | ..... |
| Abs. Vol. per group | .059 | .134 | .164 | .096 |
| Space and sub-spaces | .606 | .740 | .904 | 1.000 |
| Relative densities, $d_a$ | .097 | .181 | .181 | .096 |

$b = b^3 + b^4 = .408$, absolute volume coarse aggregate per unit vol. of concrete.

Table II—Mix for 6-Gal. Per Sack Concrete

| Materials | Abs. Vols. per Unit Vol. | Abs. Vol. per Sack | Weights per Sack |
|---|---|---|---|
| Cement | .110 | .480 cu. ft. | 94 lb. |
| Sand | 298 | 1.306 cu. ft. | 210 lb. |
| Water | .184 | .803 cu. ft. | 50 lb. |
| Mortar | .592 | 2.589 cu. ft. | 354 lb. |
| Gravel No. 4 | 108 | 0.474 cu. ft. | 78 lb. |
| Gravel No. 3 | .300 | 1.311 cu ft. | 215 lb. |
| Concrete | 1.000 | 4.374 cu. ft. | 647 lb. |

A cu. ft. of solid sand weighs 161 lb; of gravel, 164 lb.
Cement per yard is 27 divided by 4.374, or 6.17 sacks.

Table III—Coarse Aggregate for 5-Sack Concrete

| Aggregates | Factor | No. 8-No. 4 | No. 4-3/8 in. | 3/8-3/4 in. | 3/4-1½ in. |
|---|---|---|---|---|---|
| No. 4 | .098 | .016 | .079 | .003 | ...... |
| No. 3 | .266 | .007 | .031 | .143 | .085 |
| No. 2 | .097 | ...... | ...... | ...... | .097 |
| Total b | .461 | ...... | ...... | ...... | ...... |
| Sand | .281 | .031 | .011 | ...... | ...... |
| Abs. Vols | ...... | .054 | .121 | .146 | .182 |
| Spaces | ...... | .551 | .672 | .818 | 1.000 |
| $d_a$ values | ...... | .098 | .180 | .179 | .182 |

so no correction is needed, and the sand absolute-volume for this size is 0.039 × 0.300, or 0.012. The available space for this size-group is 0.904-0.164, or 0.740, and the slide rule shows that the sum of the absolute volumes may not exceed 0.134 (0.182 × 0.740). The absolute volume found for No. 3 is 0.035, and for the sand 0.012. Adding these and subtracting from 0.134 gives 0.087 as the desired absolute volume for the No. 4 gravel in this size-group, of which there is 81.0 per cent. As 0.087 divided by 0.81 gives 0.108, this is the factor adopted for No. 4.

The sum of 0.300 and 0.108 is 0.408, which is *b* the volume of the coarse aggregate on a unit basis. (Formula for the volume of concrete on a unit basis is c (cement) + a (sand) + b (coarse agg.) + v (voids) = 1.000) The percentages of No. 3 and No. 4 gravels are therefore 0.300 divided by 0.408, and 0.108 divided by 0.408, or 0.735 and 0.265, or 73.5 per cent and 26.5 per cent respectively.

The coarse aggregate may now be combined with the mortar previously computed. The coarse aggregate per unit volume of concrete is 0.408 and the volume of the mortar is 1.000-0.408, or 0.592. But the volume of mortar per sack of cement is 2.589. The absolute volume of coarse aggregate per sack is found by the proportion,

$X : 2.589 :: .408 : .592$, $X \times 1.785$. (No. 4, 0.474, No. 3, 1.311) with which the weights of sand and the gravels may be computed as shown in Table II.

### Cement and W/C specified

Suppose that the cement content is specified at 5 sacks per yard and the water-cement ratio at 6.8 gals. per sack. These determine the volume of the coarse aggregate, *b*.

From the diagram the sand-cement ratio corresponding to 6.8 gal. per sack is found to be 3.17. The absolute volume of the sand is therefore 3.17 × 0.480, or 1.522 cu. ft. The volumes per sack and per unit volume of concrete are:

| | Per Sack | Vol. Concrete |
|---|---|---|
| Cement | .480 | .090 |
| Sand (3.17×.480) | 1.522 | .281 |
| Water, 6.8 gal. | .910 | .168 |
| Mortar | 2.912 | .539 |
| Coarse agg. | 2.488 | .461 |
| Concrete | 5.400 | 1.000 |

There being 5 sacks per yard (27 cu. ft.) one sack must give 27 divided by 5, or 5.400 cu. ft. of concrete. The mortar being 2.912 cu. ft., the absolute volume of the coarse aggregate is, therefore, 5.400–2.912, or 2.488 cu. ft. per sack, or 0.461 (2.488 divided by 5.400) per unit vol.

It is evident that the factors chosen for the coarse aggregates must add to 0.461. A rough approximation was given by selecting for the Nos. 4, 3 and 2 gravels 0.100, 0.260 and 0.100 as factors, which were modified after trial to the factors 0.098, 0.266, and 0.097, respectively, as given in Table III, in which the relative densities are found to be less than 0.182. The No. 2 gravel was principally from 1-in. to 1½-in.

The weights of sand and the three gravels per sack of cement can be computed from the absolute volumes per sack as was done in Table II. They are: sand, 245 lb.; No. 4, 87 lb.; No. 3, 236 lb.; No. 2, 86 lb.

### Advantages of the method

The great advantage of this method of mix design is that it insures the greatest workability possible from the available materials for the water-cement ratio and slump chosen. It provides the most effective combination of cement and the aggregates.

The mix may be easily changed to vary the slump, the coarseness of the aggregates, the amount of cement, or the water-cement ratio. No trials need be made of new mixes.

In architectural concrete maximum workability is imperative. Where both vibration and spading are impossible or difficult, concrete is made more workable by reducing the $d_a$ values of the size-groups of the coarse aggregates well below the critical limit, 0.182. Where the bars are spaced unusually close, the ¾-in. to 1½-in. size must be left out, and in some cases a large part of the ⅜-in. to ¾-in. size, although for ordinary conditions a moderate amount of the larger size can be used in 6-in. and 8-in. walls without difficulty. In mass concrete the size-groups are kept as full as possible without particle interference for the sake of economy.

The terminal construction is under the direction of A. J. Barclay, construction engineer. Parkinson & Parkinson, Los Angeles, are consulting architects; architectural and engineering committees represent the Santa Fe, the Southern Pacific, and the Union Pacific Railroads. Robert E. McKee is the general contractor for the main building.

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## Rules for Trailer Camps Issued by Engineers

MINIMUM STATE REGULATIONS for trailer camps should embody the following items, according to a joint report of the Conference of State Sanitary Engineers and the American Public Health Association:

1—Supervision; must be competent and adequate.

2—Allotment of space per unit. A minimum of 600 sq.ft. is suggested.

3—Fires. Prohibit open, unattended fires.

4—Water supply. Require safe, potable water; ample in quantity and available from convenient outlets. At least one outlet for each two camping spaces; nozzle guards on hose for watering house trailers.

5—Toilet facilities and sewage disposal. (A) Convenient, well-constructed, lighted and ventilated toilet buildings, with proper signs. (B) Toilets within 200 ft. of every part of the camp and at least one unit for each 25 persons or fraction of that number. (C) Sanitary disposal of sewage and other wastes into sewer system or adequate private disposal system. (D) Slop sinks with can washing facilities.

6—Garbage disposal. Fly-tight metal containers; at least one for each two units. Disposal in an approved sanitary manner.

7—Shower baths and laundries. Installation of these facilities is recommended.

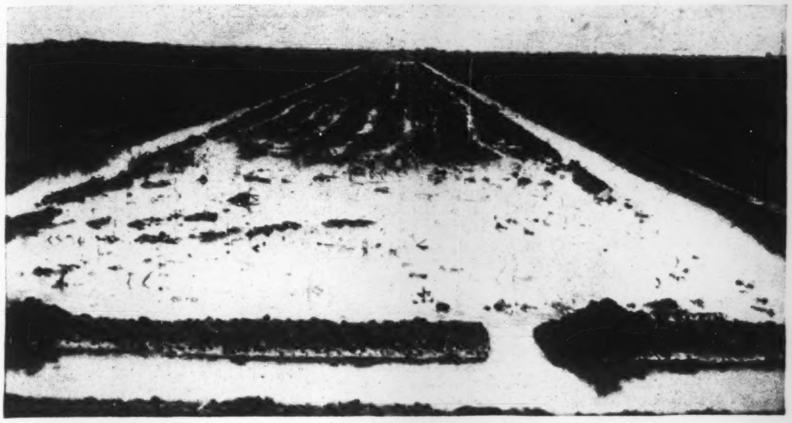

**Fig. 1.** Successive rows or strips of land are irrigated from paralleling ditches which carry the sewage effluent.

# Irrigation with Sewage

*A storage lake and land irrigation solve the sewage disposal problem at Kingsville, Tex.*

Located in a region where rainfall is low and evaporation is high, and consequently streams suitable for the disposal of sewage are practically non-existent, Kingsville, Tex., has found combination land irrigation and lake treatment to be the solution for its sewage disposal problem. The daily sewage flow, averaging 400,000 gal., is collected in a wet well and pumped to a lake some 2½ miles from the town where it is stored for irrigation use. Along the 10 in. cast iron pipe line between the lake and the town outlets have been provided at intervals so that the sewage can be diverted to irrigate adjacent land. The system was described by R. L. Peurifoy, director of engineering, Texas College of Arts and Industries, in a recent paper before the Texas Water Works Short School.

The lake has an area of 12 acres, a maximum depth of 21 ft. and a storage capacity of 90 acre-ft. During the first year of operation a total of 316 acre-ft. of sewage was pumped into the lake and 131 ft. was withdrawn for application to the land. Evaporation and seepage accounted for the difference between input and output. Evaporation (by land-pan measurement) exceeded rainfall by some 40 in.; the rainfall amounted to only 20 in. during the year.

The disposal system was put into operation during November, 1936, and sewage was pumped into the lake until January, 1937, when irrigation was started on pasture land. An average of 7 in. of effluent was found to be the most desirable amount to apply on the land which had a slope of about 1 ft. per 1,000 ft. Additional acreage on which both rhodes grass and corn were planted, was later placed under irrigation.

### Irrigation practice

The practice in irrigating the land is to apply the effluent on small areas or tracts confining it to rows or strips until the proper amount has been put on (Fig. 1). Two acres of land are irrigated each day, which represents an application of 200,000 gal. per acre per day. The soil, most of which is a sandy loam, quickly absorbs the liquid.

When operations were first started, attempts were made to irrigate strips as long as 1,250 ft. from a ditch but this practice was abandoned in favor of a system of master ditches connected with cross ditches. It was found better to irrigate narrow strips instead of wide ones because the sewage traveled to distant points more quickly and thereby reduced the tendency to waterlog the land at the head of the ditches.

Test-hole observations reveal that moisture may be put in the ground at any time sewage is available and there stored for use at least six months later. It is held desirable therefore, to irrigate the land throughout the entire year rather than merely during the growing season. Such practice not only provides more uniform sewage disposal but also aids in obtaining better crops from the land.

In discussing the operation of the lake as a treatment plant, Prof. Peurifoy reported that incoming sewage had a five-day biochemical oxygen demand of 114-173 p.p.m. while the effluent from the lake had a five-day B.O.D. of only 26 p.p.m.

Plans have now been made to irrigate more than half the land under cultivation by using sewage taken directly from the pipeline along the right-of-way. Some 360 acres will be irrigated in this fashion and 120 acres will eventually be irrigated from the lake. The availability of lake storage makes a flexible arrangement because it is thus possible to store sewage when irrigation is not in progress without interfering with disposal operations.

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## Wells Restore Lake Levels In Minnesota

Minnesota lakes have been losing water for several years due to excess of evaporation over rainfall. Adolph F. Meyer, in the November *Bulletin* of the Minnesota Federation of Architectural and Engineering Societies notes the effect of pumping ground water from the Jordan sandstone, a 90-ft. layer, 400 to 500 ft. down. From 1931 to 1937 the evaporation exceeded rainfall on Lake Minnetonka by an average of 16 in. Wells 7 miles apart have been delivering water into Christmas and Long lakes which feed Lake Minnetonka. To maintain a satisfactory level in the latter not more than ½ to 1 ft. in depth per year needs to be added. Sufficient wells to supply at least 1½ ft. are contemplated. Because of the spread of the well sites the drawdown so far has remained constant.

# Current Waterway Studies

PAUL W. THOMPSON

1st. Lieut., Corps of Engineers, Director, U. S. Waterways Experiment Station, Vicksburg, Miss.

*Current operations at the U. S. Waterways Experiment Station at Vicksburg, Miss., are going far beyond the original conception of the function of that laboratory.*

NINE YEARS AGO the U. S. Waterways Experiment Station was established at Vicksburg, Miss., as a laboratory where practical problems arising in the improvement of American rivers could be analyzed by means of small-scale models. Today such studies still constitute the principal work of the station but its activities have been enlarged to include a soil mechanics division and two "research centers". The latter act as clearing houses for information concerning current research in either hydraulics or soil mechanics. They collect the information from all available sources and disseminate it to interested offices of the Corps of Engineers.

### Hydraulic laboratory

The hydraulic laboratory, which was the first element to be incorporated in the station, remains the largest element. It is unique among similar institutions, both in the scale and in the diversity of its operations. The book-of-work of the laboratory generally contains from 10 to 20 individual studies, these representing a variety of problems: improvement of harbors, contraction of rivers, control of floods, design of spillways and outlet works, etc. Since a small-scale model study usually represents the last resort of one who has tried analytical analysis and found it wanting, it follows that the problems constituting the laboratory's book-of-work are difficult ones. Thus, a bird's-eye view of the laboratory is a bird's-eye view of a few of those especially-difficult problems which happen to be troubling the Engineer Department at the time in question.

### Present operations

The bird's-eye view mentioned above may be made most advantageously by means of a summary such as is given in Table I. In this table are noted all important studies now in progress at the Experiment Station. In the space available it is possible to note only the most essential elements of each study: problem involved, characteristics of model, notes on verification of model. Reference now should be made to the table.

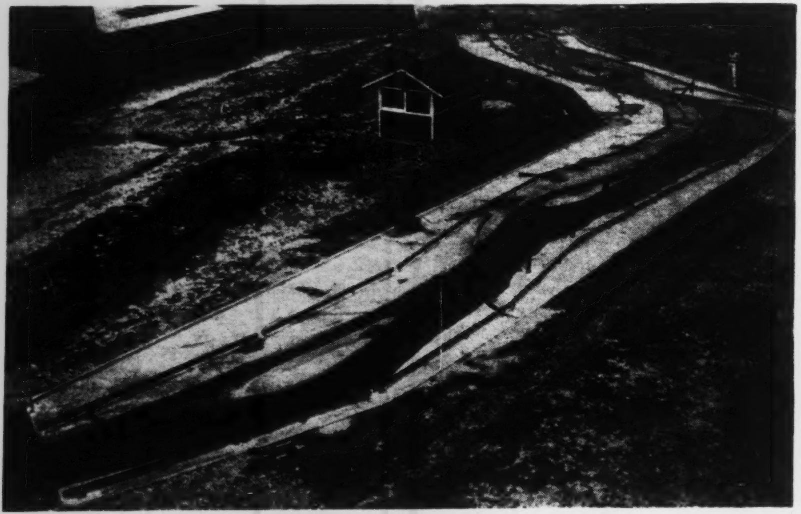

Fig. 1. A typical navigation problem under study, Pryors Island, Ohio River. The scale is indicated by the man in the upper right corner. Light weight coal is used as bed material in this model, simulating sand and gravel in the prototype.

### Studies of tidal phenomena

The first general class of studies listed in the table are those involving simulation of tidal phenomena. These are the most difficult problems with which the experimenter has to do. Thus, in the model of Galveston Harbor there must be reproduced such complex phenomena as the action of waves and tides on shifting sands; while in the model of East River, New York, there must be reproduced the intricate current conditions existing in the vicinity of Hell Gate.

Current alignments through the Hell Gate section of the East River are such as to make navigation by large ships very hazardous. The solution which was developed through an extensive analytical analysis involved the removal of about 4,000,000 cu. yd. of rock from the promontory known as Hallets Point. The East River model study has shown that the currents can be re-aligned satisfactorily with the removal of only 1,500,000 cu. yd. of material. As Hallets Point is occupied by valuable waterfront property close to the center of New York City the potential value of this finding is apparent.

About 60 miles above Cincinnati, the two Manchester Islands divide the flow of the Ohio River into three channels. It has been proposed to close one of these channels in order to obtain more satisfactory depths in the remaining ones. The Manchester Islands model study showed that the proposed closure would not have the desired effect.

In the Nov. 17 issue of *Engineering News-Record* there appeared an article in which were described the extensive operations which have occurred on the Mississippi River during the past 6 years. All of the cutoffs, enlargements, diversions, etc., which are involved in the program to curb Mississippi River floods have been analyzed by means of the large Mississippi River flood control model. This analyses of America's greatest flood problems has been a continuing project at the Experiment Station and is still in progress. Thus, recent experiments have shown the effects

TABLE I—PRESENT OPERATIONS IN THE HYDRAULIC LABORATORY OF THE EXPERIMENT STATION

| General Type of Study | Identification of Study | Problem Involved | THE MODEL | | | Comments re. Model Verification |
|---|---|---|---|---|---|---|
| | | | Area Reproduced | Scale Ratios Model-to-Prototype | | |
| | | | | Horizontal Dimensions | Vertical Dimensions | |
| **Tidal Phenomena** | Galveston Harbor, Texas... | Excessive shoaling in Galveston Harbor. | All of Galveston channel, parts of Gulf, parts of Galveston Bay. | 1 to 800 | 1 to 80 | Necessary to reproduce tides and shoaling phenomena. |
| | East River, New York..... | Unfavorable current alignments, high velocities in vicinity of and through the Hell Gate. | All of East River, all of Harlem River, Long Island Sound to Clasons Point. | 1 to 480 | 1 to 80 | Necessary to reproduce currents (alignments and velocities) and rise and fall of tides. |
| | Chesapeake and Delaware Canal, Delaware. | Probable shoaling at Delaware River entrance to deepened canal. | 5 miles of Delaware River 5 miles of the canal. | r1 to 800 | 1 to 80 | Necessary to reproduce tides and movement of bed materials. |
| | Maracaibo Bay, Venezuela.. | Inadequate depths, shifting channel across bar masking entrance to Bay. | All of bar in question and part of lake; part of Gulf of Venezuela. | 1 to 300 | 1 to 50 | Necessary to reproduce tides, littoral drift, and movement of bed material. |
| **Navigability of Rivers.** | Manchester Islands, Ohio River;<br>Pryors Island, Ohio River;<br>Chain of Rocks, Mississippi River;<br>Swiftsure Towhead, Mississippi River. | Inadequate depths at low-water (in some cases, unfavorable current alignments). | Critical area, plus several miles of river upstream and several miles downstream therefrom. | 1 to 300<br>1 to 600<br>1 to 600<br>1 to 600 | 1 to 80<br>1 to 150<br>1 to 125<br>1 to 150 | Necessary to reproduce stages and movement of bed material. |
| **Control of Floods.** | Johnstown, Pa., Conemaugh River. | Floods at junction of Stony Creek and Little Conemaugh River. | Stony Creek, Little Conemaugh River, Conemaugh River, from above Johnstown to several miles below. | 1 to 200 | 1 to 80 | Necessary to reproduce to experimentally-determined time scale flood waves actually known to have occurred. |
| | Lower Mississippi River.... | Floods below mouth of Arkansas River. | Lower Mississippi River from Helena, Ark., to Donaldsonville, La.; all floodways; all backwater areas; entire Atchafalaya system. | 1 to 2,000 | 1 to 100 | |
| **Design of Discharge Structures.** | Spillway and outlet works Sardis dam, Little Tallahatchie River.<br>Spillway and outlet works Wappapello dam, St. Francis River;<br>Spillway and outlet works (combined), Great Salt Plains dam, Salt Fork of Arkansas River. | Discharge of water from reservoir, either over spillway or through conduits; check of basic designs, development of improvements; especial reference to pressures, waves, turbulence. | Structure itself, plus parts of reservoir and exit channel sufficient to provide true entrance and exit conditions. | Spillway —1 to 70<br>Outlet works—1 to 25<br>Spillway —1 to 100<br>Outlet works—1 to 36<br>1 to 36= | | Not strictly applicable. Roughness of prototype assumed and model made correspondingly smooth or rough according to scale ratio. |
| **Miscellaneous**... | Wave-pressure analyses.... | Pressures (total and distribution of) exerted on break-waters and walls by waves of various lengths, heights, etc. | ........................ | ........................ | | ........................ |
| | Permeability of rockfill jetties. | Relative permeability of jetties having cores of rockfill varying in size-gradation. | ........................ | 1 to 4 | | ........................ |
| | Suspended load characteristics of Mississippi River. | Amount, distribution and characteristics of suspended material moved by Lower Mississippi River. | Field study data gathered at Mayersville Discharge Range, Lower Mississippi River. | ........................ | | ........................ |
| | Converging and diverging flow. | Observations of flow in diverging and converging channels. | ........................ | ........................ | | ........................ |
| | Model bed-load analyses... | Resistance to movement of various materials (coal, resin, etc.) available for use in beds of model rivers. | ........................ | ........................ | | ........................ |

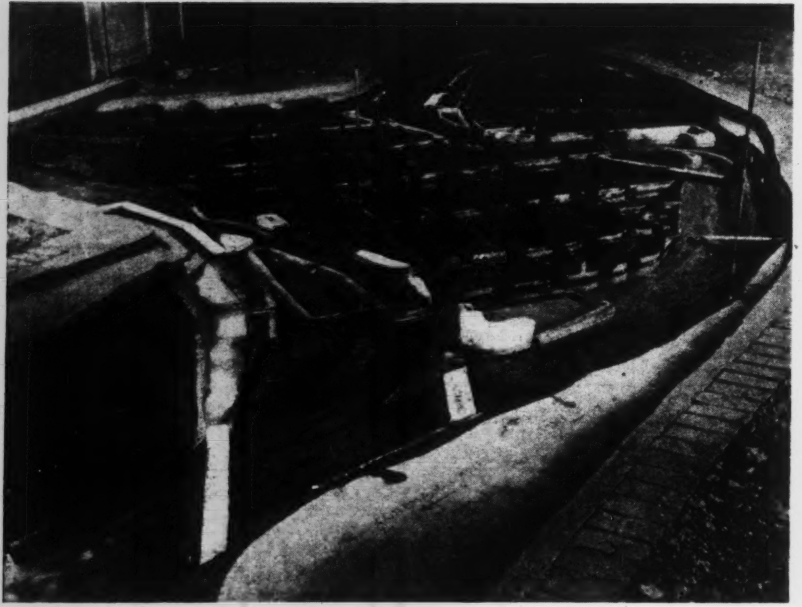

Fig. 2. **A study for the channel improvements at Johnstown, Pa. Here the 1936 flood is being reproduced to check flow conditions in the model against recorded flood heights.**

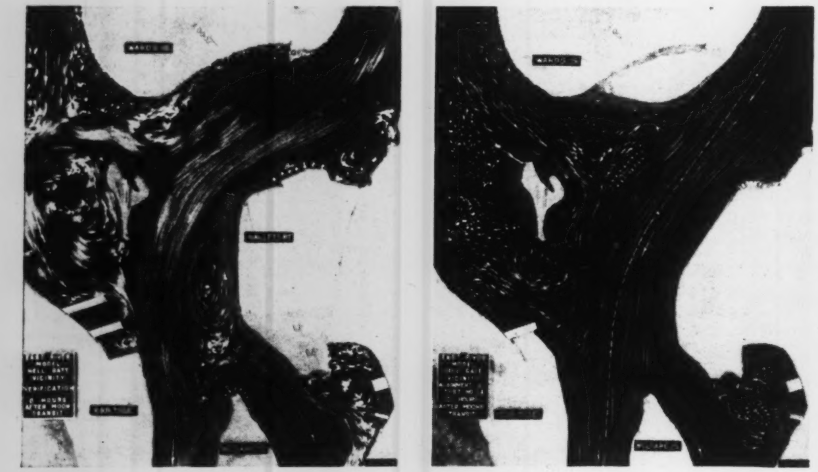

Fig. 3. **One of the most complicated flow reproduction problems ever attempted at the laboratory was accurate reproduction of the currents in Hell Gate channel at New York. It has long been believed that most of Hallets Point would have to be cut off to get a major improvement in the channel. The study showed only a minor cutting to be necessary, as indicated at the right.**

of diversion of water from the main river below Angola into the Atchafalaya Basin.

### Soil mechanics laboratory

Separate and distinct from the activities of the hydraulic laboratory are those of the soil mechanics laboratory, established in 1933. The latter is staffed and equipped to accomplish all tests and analyses normally required in construction operations having to do with earth. Thus, at the moment, the laboratory is concerned with problems as follows: control of compaction on a rolled-fill dam; investigation of the failure of a levee foundation; determination of settlement to be expected in a new warehouse; design of the section for a rolled-fill dam; study of lateral pressures exerted by submerged earth; study of means for sealing pervious strata; etc. The soil mechanics laboratory, like its hydraulic counterpart, serves engineer districts over the entire country.

### The research centers

This review of operations at the Experiment Station can be closed with brief reference to the latest additions to the station organization—that is, to the research centers. As already stated, there are two of these centers, one in the soils division, established in 1935, and one in the hydraulics division established in 1937. The work of the centers is to assemble, analyze and disseminate information. Each serve the various engineer districts through the mediums of (a) bulletins, issued periodically; and (b) answers to specific questions. To illustrate, the research centers, during recent weeks, have performed services including the following: provided District Engineer A with values of "N" for flow over bank and through urban areas; analyzed a jetty problem for District Engineer B, outlining the benefits to be expected from a model study, and estimating costs of the study; advised District Engineer C as to the effects of "bentonite" used as a grout for sealing pervious strata; collected for District Engineer D all available references on experimental studies of the filling of locks; translated for District Engineer E a German article describing a method for determining the stability of side slopes, etc., etc. The research centers simply assure that information available is used to best advantage; and that money is not wasted in duplicating information already available.

This brief review has served to indicate the scope of activities of the Waterways Experiment Station. These activities have been seen to include much experimenting, much analysis, and much processing of information. The state of affairs which has been reviewed refers to the present, but it is typical.

Granting the benefits accomplished through the station's operations, someone may be concerned about the costs involved. In this connection, the writer likes to view the situation perspectively. The cost of keeping the station in operation averages about the same as the cost of keeping one big suction or hopper dredge in operation. The actual savings made possible by many of its studies have been many times the cost.

# Reduction of Engineering Plans Cuts Operating Costs

E. L. SANDERS
Photostat Operator, State Highway Dept., Denver, Colo.

*Colorado Highway Department finds economy and convenience in photostatic reduction of plans*

ANYONE who has ever tried to spread and read a set of large plan sheets in the field with a wind blowing can readily appreciate the advantage of a set of plans small enough to be held firmly or rolled up and stuck in the hip pocket. This, however, is only one of the advantages that the Colorado State Highway Dept. is obtaining from a photostatic process of producing small-sized prints from large tracings.

The process, briefly, is to make a photostatic negative from the tracing. This negative is rendered transparent by soaking it in oil and blueprints are then made from it in the same manner as from a tracing.

Use of the photostatic negative eliminates the wear and tear on valuable tracings which naturally result from their being printed many times. After being photostated, the tracings may be filed away and kept in their original condition, while hundreds of copies are printed from the reduced negative.

The major saving from the process arises in the cost of blueprint paper. Thus, to print a job of 50 pages on full-sized 2x3 ft. sheets, would take 33 yd. of paper, costing about $1.65. The same job, printed from reduced negatives, would take 8 yd. costing about 40 cents—a saving of $1.25.

The original cost of the negatives will be about 15 cents each. An operator familiar with this type of work should be able to produce an average of about 70 negatives an hour from the original tracings. Thus, if a large number of copies of the blueprints are run, the saving in paper will very soon overcome the cost of the negatives.

There is also a marked saving in time. Making blueprints from half-sized negatives takes less than half the time involved in making full-sized prints from tracings.

The prints produced from the small negatives have the added advantage of a white background, permitting the field engineer to make any notes he may desire on the plans.

The only equipment necessary for this work is a standard photostat machine and a vertical copy board. This copy board and track can be built for a cost of about $150 complete.

As may be seen in Fig. 1, the copy board consists of a board about 5 ft. wide by 6¾ ft. high, supported on a suitable framework of 1½x1½x⅛ in. angle irons. In the center of this board is a rectangular hole which would be 28x38 in. for the standard 2x3 ft. tracing. This hole is covered by a sheet of plate glass flush with the surface of the board, on one side, and an opal diffusion glass on the other side.

If the apparatus is to be used only to reduce a standard size plan to a standard size negative, and the board is therefore to be used in only one position, this is the only equipment needed. If, however, it is desired to use different size ratios between tracing and negative, it is desirable to put wheels on the copyboard and provide tracks in which the board can move toward and away from the photostat machine. The main use of the tracks is to keep the copyboard in horizontal and vertical alignment with the photostat machine. If used, they should be installed with the greatest care. The use of an engineer's level is recommended.

The length of the track depends upon the size range desired. A length of 15.5 ft. will give a range of negative sizes from 200 to 12½ per cent of the tracing size.

The tracks used in the Colorado Highway office consist of 1¼x½ in. channel irons imbedded in concrete.

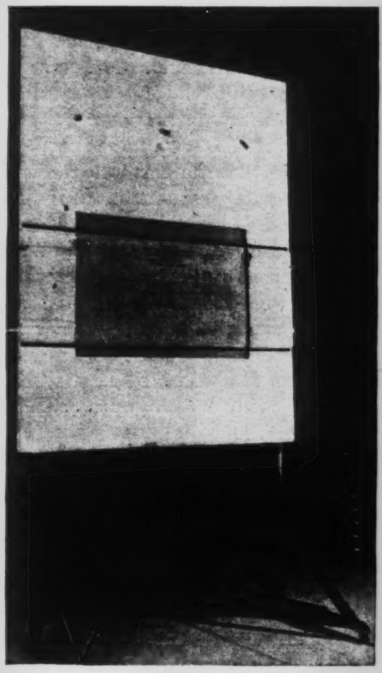

**Fig. 1.** A vertical copyboard is used with a photostat machine to reduce engineering drawings.

The correct center line of the track is determined by placing the focusing screen on the photostat machine; then a slender rod in front of the machine is moved to a position at which the image on the screen coincides with the center line of the screen. The rod is then on the center line of track, and if several such points are determined, the center line can be drawn.

The location of the end of the track nearest the photostat machine is determined as follows: Set the horizontal copyboard regularly used on the photostat machine to 200 per cent enlargement, and measure the distance from this board to the photostat prism. This distance, plus 3 in. will be the distance from the lens to the face of the vertical copyboard. By making proper allowance for the amount by which the supporting base of the copyboard protrudes forward, the location of the track can be determined. In using the vertical copyboard, of course, the prism on the front of the photostat machine is removed.

The tracing is held to the copyboard by spring clips. These may be made by removing the spring and bar from a mouse-trap and remounting on small boards which can be attached to the copyboard. The edges of the tracings are held flat by elastic bands ½-in. wide, as long as the board is wide, and fitted with wire hooks to fasten over the edges of the copyboard. These elastic bands also serve to establish upper and lower trim lines on the negative.

Grade *A* photostat paper should be used for the best results, since a heavier paper results in slower running speeds when blueprinting. If the material to be reduced is a Van Dyke positive or a C.B. tracing it should be front-lighted. Tracings should always be back-lighted. If a 50 per cent reduction is being made, lens stop No. 32 will be found satisfactory with back-lighting and No. 22 with front lighting. With back-lighting, the exposure should run from 12 to 15 sec. depending on the cleanliness of the tracing. With front-lighting, the exposure should run from 16 to 21 sec.

In lighting from the front, the light should be placed at an angle of about 40 deg. from the edge of the board and about 4 ft. in front of it. A shade about 18 in. long should be placed in the center of the lamp to avoid concentration of light on the center of the subject.

The same concentration from back-lighting is avoided by applying a coat of Bon Ami to the opal back glass, heavy in the center and blending out to about 3 in. from the edge.

The photostatic negatives are finished in the ordinary manner. Then, after drying, they are trimmed and oiled with a solution consisting of 50 per cent carbon tetrachloride and 50 per cent light mineral oil. When possible, the solution should be applied and the negatives stacked and allowed to remain overnight before the surplus oil is wiped off.

Blueprints are made from the oiled photostatic negative in the same manner as from a Van Dyke negative. If correctly made, they will run at about the same speed as cross-section sheets.

# River Crossings for Water Pipes

***Indianapolis water distribution system has several different methods of insulating the smaller size water lines that need protection at river and canal crossings***

WHITE RIVER, Fall Creek and vestiges of a 100-yr. old canal wind through Indianapolis and create a problem for the waterworks superintendent at points where the distribution pipes must cross. At seventeen places pipes are laid under the river, creek or canal in the sandy gravelly bed with 3 ft. of cover. At eight river crossings and four creek crossings bridges carry the lines.

Pipes laid in the stream beds have not given trouble for 35 years but annually in midsummer when the flow is low and clear and the line can be seen a careful inspection is made. Nearly always some repair is needed. Riprap over some of the lines may be found out of place. One year quite a hole above and below a pipe was found scoured out. Maintenance is not a material item but if it were not for the annual inspection, according to W. C. Mabee, chief engineer, subsequent high water would give trouble through undermining and ultimate breakage. These lines are laid level under the bed, and have bends up the banks with valves on each side of the stream so that the crossing can be closed off in an emergency. One 24-in. line under the river and a 12-in. line under the canal is of steel with flange joints. The balance are bell-and-spigot cast-iron pipes.

Zero weather would play havoc with lines 12 in. in diameter and under unless covered with insulation except where the velocity can be

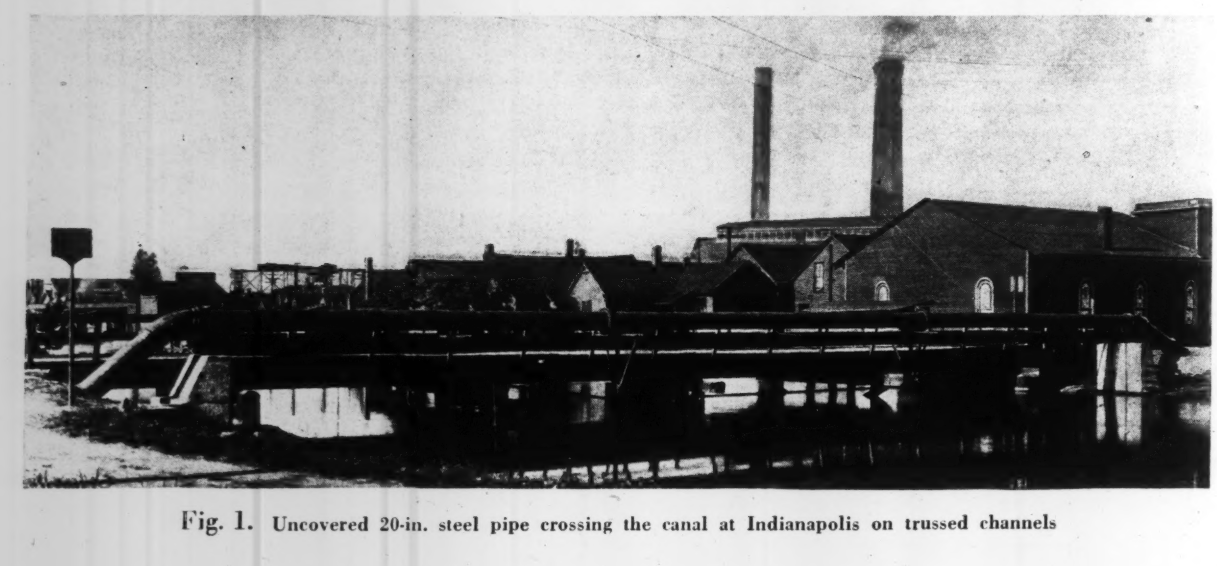

Fig. 1. Uncovered 20-in. steel pipe crossing the canal at Indianapolis on trussed channels

maintained above $\frac{1}{2}$-ft. per sec. This rate was determined largely by experience. For those lines that have small velocity and no cover 2-in. bleeders draining into the stream are provided. Whenever the temperature gets to zero the superintendent of distribution, C. M. Winkle, opens the bleeders to give the equivalent of a 1-in. stream. The bleeder is allowed to discharge until the temperature rises materially above zero.

Soil insulation is a little known factor according to Mr. Mabee and varies in different latitudes. In Indianapolis, which is underlaid with sand and clay, pipes are laid with $3\frac{1}{2}$ ft. cover. For the bridge crossings four different methods have been used. The cheapest method, which is satisfactory where it can be applied and kept dry, is a box in which the pipe is covered with from 4 to 6 in. of sawdust. Three 1-in. layers of animal hair laminations with a covering of tarred felt paper to keep out the weather has proved satisfactory. Three layers of Johns-Manville standard corrugated abestos insulation wrapped with an asphaltic saturated felt and secured with jute yarn has given good service. A local rock and cork concrete product used largely for insulation of steam lines, where it is said to conserve 90 per cent of the heat, has been placed on recent installations. For the small sizes it is made 3 in. thick in halves with the 2-in. inner layer largely of cork and the outer 1-in. shell of rock-cork concrete wherein the cork is a much smaller percentage. A $\frac{1}{2}$-in. space between the pipe and the insulation shell provides additional dead-air insulation. None of the Indianapolis crossings were frozen in the severely cold winter of 1936 but a few mains with inadequate cover gave trouble.

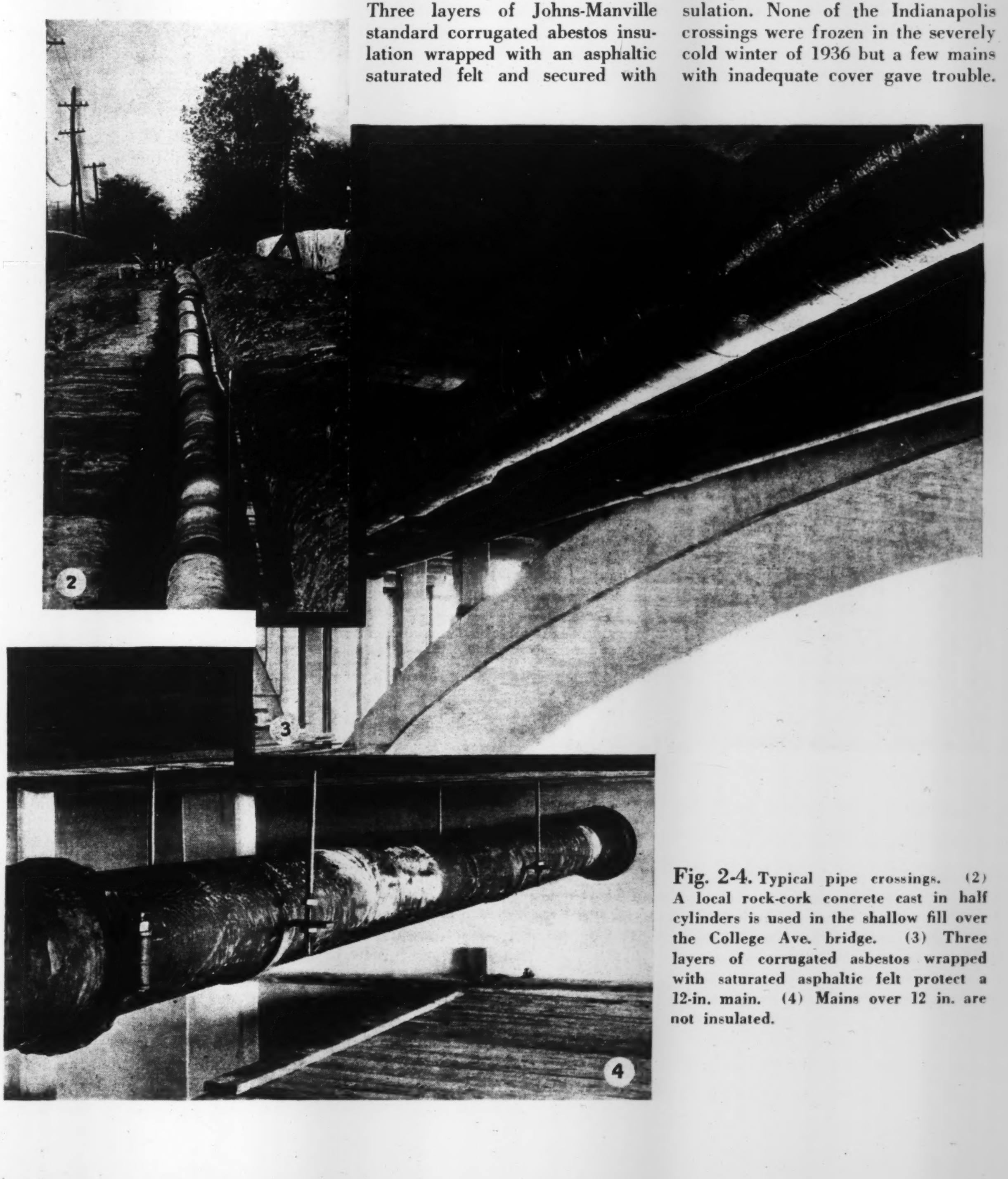

**Fig. 2-4.** Typical pipe crossings. (2) A local rock-cork concrete cast in half cylinders is used in the shallow fill over the College Ave. bridge. (3) Three layers of corrugated asbestos wrapped with saturated asphaltic felt protect a 12-in. main. (4) Mains over 12 in. are not insulated.

# *BOOK NOTES AND REVIEWS*

*The month's additions to the engineer's reading and reference list*

## Hurricane Effects

NEW ENGLAND HURRICANE—A Factual Pictorial Record—Written and compiled by Federal Writers' Project of New England. 220 pp. Published by Hale, Cushman & Flint, Boston. Price $1.50.

Promptly after the great hurricane that swept New England on Sept. 21, the WPA writers' project sent men into all corners of the affected region to gather a pictorial record. The results are now available in book form. Its entire contents consists of pictures explained by rather ample, informative captions. Anyone who did not see the hurricane ruins with his own eyes will find it worthwhile to look over and preserve the book—which, incidentally, is a creditable evidence of initiative on the part of WPA planning authorities.

## Water Works Accounting

MANUAL OF WATERWORKS ACCOUNTING—Prepared by the Municipal Finance Officers Association, Chicago, and the American Water Works Association, New York City. 504 pp. Price $4.

No longer need the various waterworks officials of different properties wrangle over comparative financial statistics. This manual, prepared by two professional associations, both leaders in their fields, describes and illustrates every part of the waterworks and accounting process. Some 166 forms, tables and charts are included. Thus comparison of management methods in the 12,000 waterworks plants of the country could be made available for the first time through the adoption of these procedures, which are adaptable for all public and private water utilities. Information on the financial condition of utility property can now be made available in a uniform way to public service commissions, stockholders, municipalities as well as the customers.

In addition to general accounting methods, the book covers such phases as depreciation, investments, purchasing inventories, budgeting and customer billing. Three alternate successfully used methods are given of billing and collecting accounts. The manual is not to be confused with a classification of accounts. Standard classifications are accepted.

Committees of the two associations supervised the preparation of the manual which was carried out by a full time staff set up for the purpose. Committee members reviewed a preliminary draft and a "Final Approval Committee" rendered final decision as to suggested changes. Thus while water plant managers and accountants were the primary group for whom the manual was prepared, representatives of all sections of AWWA reviewed it to be sure that it is practical.

## Transportation

A HISTORY OF TRANSPORTATION IN CANADA—By G. P. de T. Glazebrook. 475 pp. Published by the Carnegie Endowment for International Peace by The Ryerson Press, Toronto; Yale University Press, New Haven. Price $4.

TRANSPORTATION ON THE WESTERN FRONT: History of the Great War. Compiled by Col. A. M. Henniker (British official). 531 pp. and separate folder of maps. Published by His Majesty's Stationery Office, London. Obtainable from the British Library of Information, 270 Madison Ave., New York. Price $5.50.

There seems to be little relation between transportation in Canada and international peace, but the Carnegie Endowment for International Peace is to be thanked for having financed Prof. Glazebrook's comprehensive history. In an earlier volume of the same series—The Railway Inter-relations of the United States and Canada (*ENR* Apr. 28, p. 628)—Wm. J. Wilgus sketched briefly the history of early transport along the border previous to the coming of the railroads. In the present work Prof. Glazebrook gives a much fuller review of the early days of when Canada's major industry was fur trading and transport of furs to the ocean ports. There follows a well documented account of the building of railways in the eastern provinces, then the struggle to tie the country together with a transcontinental line built through the rugged wilderness of Northern Ontario, and finally the developments that lead to the setting up of the Canadian National Railways system. There also are chapters on Canada's waterways, and on road, air and electric transport.

Turning from peace-time activities of Canadians, it may be noted that in war days they had a lot to do with transportation on the Western Front. Canadian engineers, therefore, will find much of interest in Col. Henniker's history, though it is much more difficult reading than is Prof. Glazebrook's book, due no doubt to the necessity of getting into such an official record a lot of dry (and mostly quite useless) statistics. But among the statistics will be found many statements which when pieced together give a better picture of what went on behind the British lines than was available to most of the Canadian engineers who took such a major part in the great effort to keep men and munitions moving regularly between the sea coast and the trenches. American engineers who had a modest share in that work also will find items of interest in the book.

## Encyclopedia of Welding

WELDING HANDBOOK—1938 Edition—1,211 pp. Published by the American Welding Society, 33 W. 39th St., New York. Price $5 to members; $6 to nonmembers in U.S.A., $6.50 elsewhere.

Welding has developed so fast and on so many fronts that only the specialists can truly be said to be completely competent in its use. And even they often need guidance outside their specialties. Such a condition no doubt prompted the American Welding Society to compile this welding handbook which more accurately should be called an encyclopedia since the various branches of the art are treated in separate articles. It is a significant and important addition to engineering literature for it brings together for the first time all the fundamental knowledge and current practice in an art that already has profoundly affected many industries. The book is not a substitute for the texts in the various specialties or branches of the art—welded building design, for example, is covered in only 27 pages, and the welding of low alloy steels in 44 pages—but between the text and the bibliographies the reader has available a large dose of basic and authoritative information.

The volume is divided into three parts: (1) Fundamentals of the various processes; (2) the materials used and the testing methods involved; and (3) the applications of the various processes. Data are also included on metal cutting and on a number of processes allied to welding and cutting. Each of the various chapters of the book has been written by a specialist, 90 of the leading authorities in the welding field being listed as authors. In addition, each section was submitted to other authorities for review before publication, and it is stated that 237 of these reviewers also contributed their knowledge to the book. The "Handbook Editorial Committee" of the American Welding Society consists of B. S. Jacobus, chairman; C. A. Adams, F. E. Llewellyn, D. W. Obert and W. Spraragen, editor.

## Air Conditioning

AIR CONDITIONING—By Charles A. Fuller. 577 pp. Published by The Norman W. Henley Publishing Co., New York. Price $4.

AIR CONDITIONING—Second Edition. By James A. Moyer and Raymond V. Fitz. 455 pp. Published by McGraw-Hill Publishing Co., New York & London. Price $4.

Four recent books on air conditioning were noted in *ENR* June 23, p. 887. Two more now have been added to the considerable number of current books on that subject.

The Moyer and Fitz book is an extensive revision of a text published originally in 1933. Written by teachers, the book is designed primarily for the use of students. Part of the text of the first edition has been revised in the light of recent developments and new material has been added, including a set of practical air-conditioning problems, and data on heat transmission through building materials.

The Fuller text is designed to meet the requirements of those, who, lacking training in higher mathematics, seek to gain an understanding of air conditioning principles and the practical application of air conditioning equipment. Use of technical phraseology is avoided wherever possible and the book is so written as to be understandable by a person having a fair knowledge of mathematics. Methods for determining the air-conditioning needs of major types of commercial, industrial and domestic buildings are given as is information concerning the principal methods of heating, cooling and air conditioning. One chapter gives a summary of codes and ordinances affecting air conditioning.

## *MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS*

IRRIGATION VERSUS WATER POWER in Nebraska is the subject of a pamphlet published by the Committee of Utility Executives, Washington, D. C.

WHAT THE HOUSING ACT CAN DO FOR YOUR CITY, a pamphlet by the U. S. Housing Authority, may be obtained from the Superintendent of Documents, Washington, D. C., for 20¢.

HOUSING CONSTRUCTION under the Mopin system as developed and used in France is the subject of a report issued by the Division of Foreign Housing Studies, Works Progress Administration, 10 E. 40th St., New York City.

SPECIFICATIONS for the design, fabrication and erection of structural steel for buildings, originally adopted by the American Institute of Steel Construction in 1936, have been revised and republished in pamphlet form. Copies may be obtained for ten cents from the Institute headquarters, 200 Madison Ave., New York City.

PAPERS AND DISCUSSIONS at the first public forum held under the auspices of American Engineering Council in Philadelphia last May have been published in pamphlet form and are available from the Council headquarters in Washington for 15¢. The subject of discussion at the forum was "Employment and the Engineer's Relation to It."

MODEL TESTS of latticed structural frames built of aluminum alloy have been made the subject of technical paper No. 2, Aluminum Research Laboratories, Aluminum Co. of America, Pittsburgh, Pa. The investigation was originally undertaken in connection with the design of aluminum alloy dragline booms. It was extended to include all frames constructed with continuous chords joined by a system of latticing.

## *NEW PUBLICATIONS*

THE DESIGN OF DAMS—By Frank W. Hanna and Robert C. Kennedy. 478 pp. Published by McGraw-Hill Book Co., New York & London. Price $5.

MARYLAND'S PRIMARY BRIDGE PROGRAM—Report Submitted to State Roads Commission of Maryland—By J. E. Greiner Co. Vol. I, Report on Crossings; Vol. II, Plates (large). 169 and 85 pp. Published by the State Roads Commission of Maryland.

WATER SUPPLY AND PURIFICATION—By W. A. Hardenbergh. 458 pp. Published by the International Textbook Co., Scranton, Pa. Price $4.

BIG BRIDGE—New and Revised Edition—By Rupert Sargent Holland. 281 pp. Published by Macrae-Smith Co., Philadelphia. Price $2.

AMERICAN HIGHWAYS AND ROADSIDES—By Jac L. Gubbels. 94 pp. Published by Houghton Mifflin Co., Boston. Price $2.75.

THEORETICAL HYDRODYNAMICS—By L. M. Milne-Thomson. 552 pp. Published by Macmillan and Co., London, and the Macmillan Co., New York. Price $11.25.

THEORETICAL MECHANICS—By C. J. Coe. 554 pp. Published by the Macmillan Co., New York. Price $5.

LEFAX TRAVERSE TABLES—By J. T. Boileau. 92 pp. Published by Lefax, Inc., 9th & Sansom St., Philadelphia. Price $1.50 (paper).

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RESULTS OF RESEARCH WORK—Soil Mechanics and Foundation Research Laboratory, Period 1933–1936. By W. S. Hanna, G. Tschebotareff and M. K. Khalifa. Published by Fouad I University, Cairo, Egypt.

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ANNUAL REPORT OF THE CITY PLAN COMMISSION OF ST. LOUIS, Mo. 1937–1938. 125 pp. Prepared and published by the City Plan Commission, 324 Civil Court House, St. Louis.

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# CONTRACT UNIT PRICES

*What contractors are bidding on different kinds of construction work*

## *HIGHWAYS, WYOMING*

**OWNER:** U. S. Bureau of Public Roads, Denver; B. W. Matteson, acting district engineer.

**PROJECT:** Construction of 2.177 miles of grading and bituminous surfacing on the Hoback Canyon route in Teton National Forest, Wyoming, including one highway bridge.

**BIDS:** Nine bids were received Nov. 22, 1938, ranging from the contract low of $79,675 to $97,785.

**LOW BIDDERS:**

| | |
|---|---|
| 1. Chas. M. Smith Thermopolis, Wyo. (contract) | $79,675 |
| 2. Olof Nelson Construction Co., Logan, Utah.. | 86,826 |
| 3. Northwestern Engineering Co.. Rapid City, S. D. | 88,000 |

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Uncl. excav | 66,000 c. y. | $0.16 | $0.24 | $0.24 |
| 2. Uncl. excav. struct | 2,300 c. y. | 2.50 | 2.00 | 3.00 |
| 3. Uncl. excav. borrow | 9,000 c. y. | .16 | .20 | .26 |
| 4. Sp. overhaul | 310,000 sta. yd. | .02 | .02 | .02 |
| 5. Sp. overhaul | 11,000 yd.-mi. | .30 | .20 | .20 |
| 6. 3 in. heavy base course | 15,200 tons | .65 | .50 | .50 |
| 7. Watering | 600 M. gal. | 1.50 | 1.00 | 2.00 |
| 8. Roller operation | 150 hr. | 5.00 | 4.00 | 4.00 |
| 9. Furn. roller | 1 only | 200.00 | 200.00 | 150.00 |
| 10. Water plant or plants for project | L.S. | L.S. | L.S. | L.S. |
| 11. Crusher run top course | 3,700 tons | .65 | .54 | .80 |
| 12. MC-1 cutback asphalt, prime coat | 18,000 gal. | .12 | .18 | .15 |
| 13. Cl. "A" concr | 569 c. y. | 21.65 | 24.50 | 25.00 |
| 14. Cl. "D" concr | 122 c. y. | 22.60 | 26.00 | 25.00 |
| 15. Reinf | 62,400 lb. | .0575 | .07 | .055 |
| 16. Struct. steel, incl. guard angles, pipe drains, and gratings | 143,800 lb. | .065 | .08 | .07 |
| 17. Tr. timber, salts pres. incl. bridge iron | ½ M.b.m. | 200.00 | 100.00 | 200.00 |
| 18. 24-in. C.G.S.M. pipe | 970 l. f. | 2.95 | 3.20 | 3.10 |
| 19. 36-in. C.G.S.M. pipe | 152 l. f. | 5.85 | 6.00 | 6.09 |
| 20. Loose riprap | 80 c. y. | 2.50 | 4.00 | 3.00 |
| 21. 6-in. Perf. C.S.M.P. underdrain | 600 l. f. | 1.50 | 1.00 | 1.50 |
| 22. Conc. maint. posts | 12 ea. | 7.00 | 4.00 | 15.00 |
| 23. 20-in. cattle guard | 1 ea. | 700.00 | 1,000.00 | 1,000.00 |
| 24. Barbed wire fence | 23,200 l. f. | .07 | .10 | .065 |
| 25. 12-in. gates | 12 ea. | 17.00 | 15.00 | 20.00 |
| 26. Removal of old struct | L.S. | L.S. | L.S. | L.S. |
| 27. Relaying C.G.S.M. pipe | 76 l. f. | .50 | .50 | 1.00 |
| 28. Moving gov. telephone line | 1 mi. | 150.00 | 250.00 | 150.00 |

## RAILROAD RELOCATION, *CALIFORNIA*

**OWNER:** U. S. Bureau of Reclamation; Walker R. Young, engineer.

**PROJECT:** Earthwork, construction of tunnels and structures on Southern Pacific Railroad relocation around Shasta Dam in northern California, from milepost 287.81 to 288.725 not including the superstructures for two bridges across the Sacramento River. Project includes earthwork and other structures. Tunnel No. 11 is 1000 ft. long, and tunnel No. 12 is 916 ft. long.

**CONDITIONS:** The contractor is to begin work within 30 days of the date of receipt of notice to proceed, is to complete the piers and abutments for the Sacramento River bridge, fourth crossing, and the grading from milepost 288.725 to that point in 190 calendar days; he is to complete piers and abutments for the third crossing of the Sacramento in 220 calendar days; and he is to complete all work for the contract within 240 calendar days. The government will furnish cement for use in concrete, mortar and grout; reinforcement; and most other items that will becom a permanent part of the construction. Contractor will furnish aggregates; backfill materials; form work, and othe items that will not become a permanent part of the construction. Access to the work is to be provided by the contractor.

**BIDS:** Nine bids were received Nov. 14, 1938 ranging fro $598,673 to $729,141. Minimum labor rates are as follows skilled, $1.25 per hr.; semi-skilled, 90c. per hr.; common 75c. per hr.

**LOW BIDDERS:**

| | |
|---|---|
| 1. United Concrete Pipe Corp., Los Angeles.... | $598,673 |
| 2. Clyde W. Wood, Los Angeles | 618,016 |
| 3. Sam Orino, Portland, Ore. | 626.578 |

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Clear right-of-way | 10 acre | $400.00 | $100.00 | $150.00 |
| 2. Excav. common, roadway | 41,200 c. y. | .95 | .90 | .55 |
| 3. Excav., rock, roadway | 58,200 c. y. | .95 | .90 | .55 |
| 4. Overhaul | 493,500 sta. yd. | .01 | .005 | .0075 |
| 5. Water, moist. embank | 265 M. gal. | 2.00 | 2.00 | 2.00 |
| 6. Rolling embank | 45 roller-hr. | 8.00 | 8.00 | 10.00 |
| 7. Riprap | 3,000 c. y. | 2.00 | 1.50 | 1.25 |
| 8. Excav. common, struct | 9,000 c. y. | 3.00 | 1.00 | 3.00 |
| 9. Excav. rock, struct | 3,700 c. y. | 3.00 | 2.00 | 10.00 |
| 10. Excav. all classes, in tunnels | 35,000 c. y. | 6.00 | 7.50 | 5.00 |
| 11. Perm. steel tunnel supports | 379,000 lb. | .08 | .08 | .12 |
| 12. Perm. timbering in tunnels | 33 M.b.m. | 120.00 | 80.00 | 75.00 |
| 13. 8-in. tunnel drains | 700 l. f. | 2.00 | 1.00 | .30 |
| 14. Install. metal drain and weep pipes in tunnels | 18,000 lb. | .12 | .05 | .06 |
| 15. Drill. weep holes in tunnels | 800 l. f. | 2.00 | 1.50 | 1.00 |
| 16. Conc. tunnel lining, except in inverts | 8,700 c. y. | 10.45 | 10.00 | 14.00 |
| 17. Conc. tunnel inverts | 600 c. y. | 9.00 | 8.00 | 12.00 |
| 18. Conc. tunnel portals | 1,850 c. y. | 10.50 | 13.00 | 16.00 |
| 19. Conc. struct. except in bridge piers and abutments | 70 c. y. | 25.00 | 15.00 | 20.00 |
| 20. Conc. footings of bridge piers | 1,200 c. y. | 9.00 | 11.00 | 12.00 |
| 21. Conc. bridge piers above footings | 3,400 c. y. | 11.35 | 13.00 | 16.00 |
| 22. Conc. bridge abutments | 830 c. y. | 12.00 | 13.00 | 13.00 |
| 23. Placing reinf | 840,500 lb. | .015 | .015 | .025 |
| 24. Placing rag bolts, anchor bolts, and anchor-bolt sleeves | 6,000 lb. | .15 | .05 | .10 |
| 25. Spl. finishing of conc. surf. | 650 s. y. | .40 | 1.00 | .30 |
| 26. Dry-rock pav | 350 s. y. | 3.00 | 2.00 | 5.00 |
| 27. Backfill about struct | 12,000 c. y. | .50 | .25 | .50 |
| 28. Compact. backfill about struct | 2,000 c. y. | .60 | .50 | .50 |
| 29. Laying 24-in. diam. cor. metal pipe | 148 l. f. | 1.00 | 1.00 | 1.00 |
| 30. Const. 8-in. per pipe track drains | 72 l. f. | 1.50 | 1.00 | 1.00 |
| 31. Install. elec. conduits in tunnels | 8,100 l. f. | .15 | .15 | .25 |
| 32. Const. barbed-wire right-of-way fences | ½ mi. | 500.00 | 300.00 | 500.00 |
| 33. Const. woven wire right-of-way fences | ½ mi. | 600.00 | 300.00 | 500.00 |

## HIGHWAYS, SOUTH CAROLINA

**OWNER:** Lancaster County Commission, S. B. Sapp, chairman.

**PROJECT:** Constructing 8 mi. of highway improvement from Heath Springs to Kershaw County line. Improvment includes earth type base course and inverted penetration type bituminous surfacing. Stipulated contract time is 120 working days. Highway transportation is to be used.

**BIDS:** Eight bids were received Oct. 29, 1938, ranging from the contract low of $37,584 to $51,119. Minimum labor rates

(*Contract Unit Prices continued on second following page*)

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"Ask the man who *handles* one"—and you will find that LAY-SET Preformed wire rope gets the vote. It is the fellow who handles and works with LAY-SET that *knows* it to be the dependable, *safe,* long-life line. He knows LAY-SET Preformed is a relaxed, limber, flexible, easy-and-safe-to-handle rope. He knows it resists kinking and whipping; that it spools perfectly and almost refuses to rotate or twist in sheave grooves. He knows broken crown wires lie flat and in place and don't wicker out to tear his hands with chisel-like jaggers. He knows LAY-SET Preformed lasts longer—pays better dividends in both rope costs and production.

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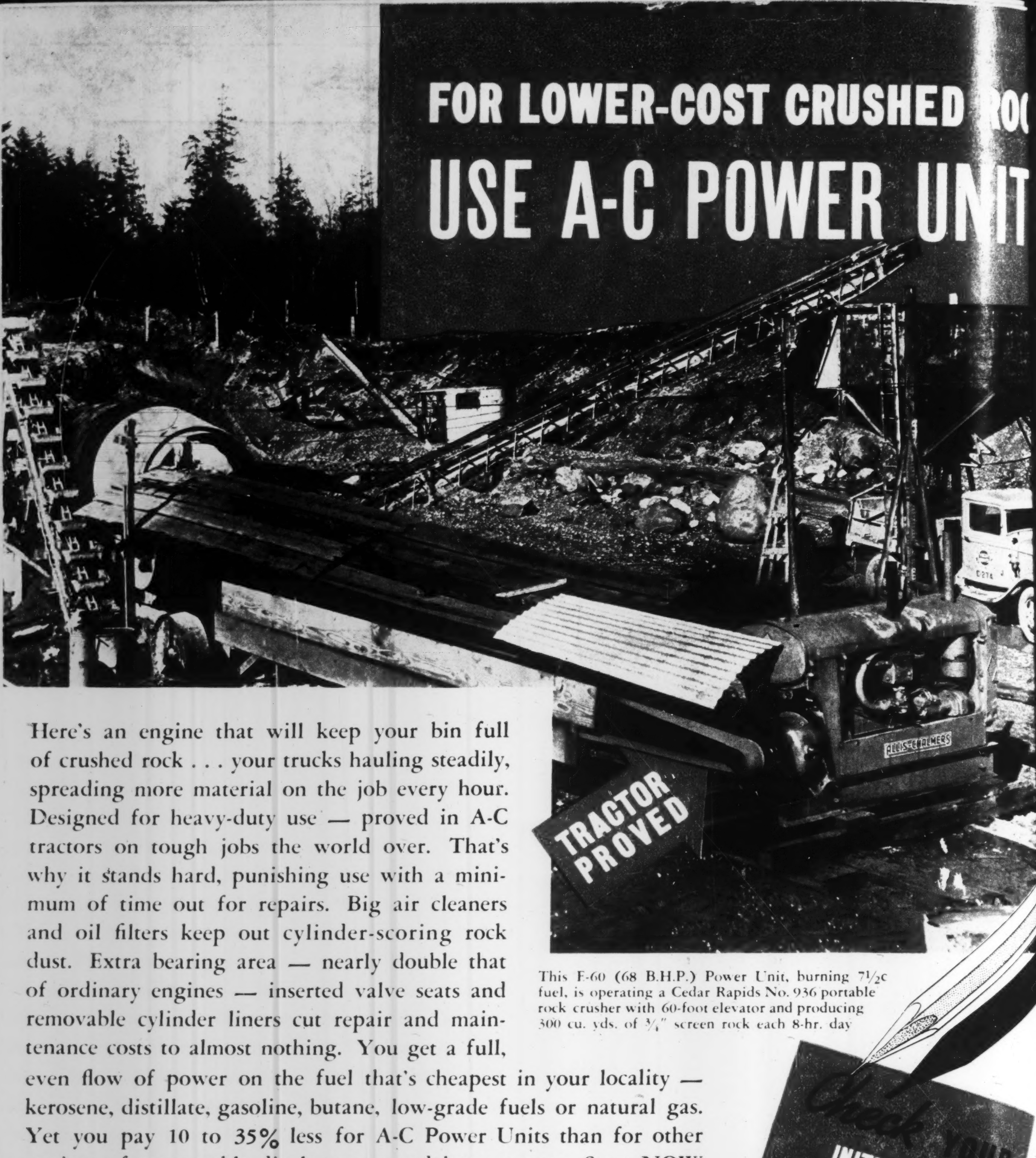

This F-60 (68 B.H.P.) Power Unit, burning 7½c fuel, is operating a Cedar Rapids No. 936 portable rock crusher with 60-foot elevator and producing 300 cu. yds. of ¾" screen rock each 8-hr. day

Here's an engine that will keep your bin full of crushed rock . . . your trucks hauling steadily, spreading more material on the job every hour. Designed for heavy-duty use — proved in A-C tractors on tough jobs the world over. That's why it stands hard, punishing use with a minimum of time out for repairs. Big air cleaners and oil filters keep out cylinder-scoring rock dust. Extra bearing area — nearly double that of ordinary engines — inserted valve seats and removable cylinder liners cut repair and maintenance costs to almost nothing. You get a full, even flow of power on the fuel that's cheapest in your locality — kerosene, distillate, gasoline, butane, low-grade fuels or natural gas. Yet you pay 10 to 35% less for A-C Power Units than for other engines of comparable displacement and horse-power. Start NOW to save money on power costs. See your nearest Allis-Chalmers dealer. Ask him about A-C Power Units for operating crushers, pumps, hoisting winches, mixers, compressors, generators, etc.

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